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CANADA'S NATURAL RESOURCES AND THEIR STATE CONTROL

The Hon. Arthur Meighen, K.C., Minister of the Interior

Address at the Meeting of the Society, 24 June 1918.

THIS audience is gathered under the auspices of an institution of long and distinguished history, and I gratefully acknowledge the kindness by which I am permitted to appear upon its programme. The normal activities of this Society have, as your Secretary has informed me, been interrupted and in important directions suspended by the rude clang of war. It is not the part of Britons, though, to surrender to naked force what has been found to be good, and for that reason your organization keeps its strength and lends its resources to the great cause. "By these things men live," and long may the Royal Geographical Society survive the agony of this conflict and the accursed system that brought it on.

I have had the advantage of a perusal of several issues of your *Journal* —a precaution undertaken, unfortunately, after instead of before my acceptance of the invitation to address you. This perusal has emphatically convinced me of my inability to contribute any material of that scientific and informative character which distinguishes past performances from this platform, and I am free to say that had my inquiry and study preceded my rather hasty acquiescence in your kind proposal, you would have been spared the digression on which I now am launched.

It will be impossible for me to add anything of value or very much of interest to the knowledge of those who hear me of the geography of Canada. Our Governmental activities have been commercial rather than explorative. Our country is young, our territory is vast. The Dominion is indeed in extent something akin to a continent, and in its 3,729,000 square miles of area approximates closely to the dimensions of Europe.

Its more accessible and productive regions have offered such obvious and distinct advantage to the settler that these portions have almost wholly absorbed the attention of our population, so much so that definite information as to our great hinterland is meagre in the extreme. The unexplored area in 1916 is estimated by Mr. Camsell at 900,000 square miles, or 25 per cent. of our entire domain. It stretches with casual interruptions from Hudson's Bay westward to the Yukon and eastward to

the Labrador coast. The best I can do is to present with what clearness I may a brief topography of the Dominion and a partial sketch of her possessions. There may be much in what I say characterized by indefiniteness and of the nature rather of indications than of positive ascertainment, but such is necessarily unavoidable in the present state of Canadian prospecting and exploration.

Canada may be likened to a monstrous torso resting on the American Continent, both arms being severed by political divisions. Alaska on the west has gone to the United States, and Newfoundland, the oldest British possession, remains aloof on the east. Nevertheless the area remaining is somewhat larger than the United States, Alaska included.

Speaking broadly, the general slope of the country is northward, some 2 million square miles—or over half—draining into the Arctic Ocean and Hudson's Bay. About 1½ million square miles fall towards the east, draining into the North Atlantic, and about half a million square miles on the western coast beyond the Rocky Mountain range drain into the Pacific. Only a comparatively negligible basin, less than 13,000 square miles at the south-west end of the western prairies, drains into the Gulf of Mexico.

To obtain a systematized view of Canada's general physical features, and consequently of her mineral contents, it is convenient to make a few bold divisions. In geological formation the maritime provinces of Prince Edward Island, Nova Scotia, New Brunswick and the south-east portion of the Province of Quebec constitute the northern end of the Appalachian mountain system. The chief basic constituent is pre-Cambrian rock (covered of course in the main with later and more fertile deposits), and within this geological province are found the minerals that inhabit the Appalachian system along the Atlantic States and that have added so much to their wealth. Coal, iron, and gold predominate, the first-named being up to the present of the greatest importance commercially. The significance in the national balance-sheet I will call to attention later. The next geological province is the lowlands of the St. Lawrence basin, draining from both south, north, and west into this mighty river. This formation is Palæozoic. The minerals found and the nature and productiveness of the surface generally are true to the record everywhere of that formation. Over this territory is now spread the larger portion of the population of Canada.

What I might describe as the main framework geographically and geologically of the Dominion is the Laurentian Plateau. This is a tremendous V-shaped territory stretching from Newfoundland and Labrador on the Atlantic coast across the Provinces of Quebec and Ontario around the southern basin of Hudson's Bay, and thence northerly, and to some extent westerly, toward the vast northland. As every one knows, the rock formation of this plateau is of granite character and of pre-Cambrian age. It is widely believed that at one time the great mass, if

not all, of North America was constituted by this formation, the overlying strata and deposit now existing being the product of succeeding ages of erosion, volcanic action and vegetation. This pre-Cambrian granite abounds throughout Canada in the minerals characteristic of that formation everywhere, viz. in copper-nickel, cobalt, silver, zinc, lead, and iron. A tongue of these rocks projects southerly into the State of New York, and supports there some of the large and varied mineral industries of that State. Another tongue crosses southerly from Canada into the States of Michigan, Wisconsin, and Minnesota, and contributes to these States the Michigan copper mines and the great Lake Superior iron ranges. It may be of interest to know that the products of these mines, though they are out of Canada, contribute more as yet to the traffic of the great lakes than even the tremendous wheatfields of the West. Within the body of this plateau in Canada are found the great nickel mines of Sudbury in Central Ontario, from which mines the British Empire and the Allies in this war have drawn almost all their nickel supply, so vital now to military and naval equipment. Close by are the great Cobalt silver deposits, and further to the east are the corundum deposits of Ontario and the molybdenite and asbestos deposits of Quebec. The latter, and as well the nickel deposit, are the largest respectively in the world. On the extreme east, though in Newfoundland and not in Canada, are the world's greatest iron mines—mines which, in furnishing the material for our steel production, have contributed vastly to the war effort of Canada. All the great minerals known to occur in the developed southern edge of this plateau have been noted by explorers in the northern reaches of the same formation. Copper in particular seems to be abundantly prevalent in the northern and western expanses, so much so that discoveries are heard of from almost every quarter, wherever the prospector travels. The Eskimo, who are located at various points north-westerly from Hudson's Bay to the Arctic, have their spears, snow-knives, ice-chisels, fishhooks, and arrow-heads beaten out of pure native copper, and even use copper tops for their smoking-pipes. Their stories agree with the explorers' as to the vast quantities of native copper along the Arctic coast and on islands near the coast. Within the present populated area, however, there have recently been discovered deposits of this metal of present commercial importance. One mine lately opened at Scist Lake, north-west of The Pas, is so rich in copper that the ore has been shipped in very substantial quantities, 40 miles drawn by wagons to the Saskatchewan River, 190 miles taken by barges down the river to The Pas, and thence 1500 miles by rail to the smelter in British Columbia; and after carrying this burden of transportation so rich is the ore that it yields a handsome profit.

The Atikonan iron range just west of Lake Superior, and the Michipicoten mining district to the north of the same lake, are the conclusive evidence of the presence of commercial iron in the northern as well as the southern reaches of this plateau. The immensity of the deposits of these

various minerals that will in good time be uncovered, as well as the meagre character of our information as to the earth contents of our country, may be judged from the fact that the nickel mines just referred to were unknown until about twenty years ago, when they were accidentally discovered in the construction of a railway. The premier silver camp of Canada at Cobalt, although only a few miles from one of the earliest routes of travel and from the silver-lead deposits known for 150 years, remained undiscovered until fifteen years ago.

To the west and south of the Laurentian Plateau is the great interior plain constituting the larger portion of Manitoba, Saskatchewan, and Alberta. This territory is principally agricultural and is underlain by a rock formation of later Cretaceous age. This formation contains coal in great abundance, as well as mineral clays and cement material.

On the farthest west comes the fifth and last geological province: the Cordillera. This is the northern projection of the great Cordillera range that extends over the whole western coast of North America and covers a territory in Canada 1300 miles north and south by about 400 miles in width. Included in it is the mountainous region of British Columbia and the Yukon. The entire range stands unparalleled in the world for the continuity and extent of its mineral resources, and in Canada as well as in Alaska are to be found within its folds the same deposits of gold, coal, copper, lead, and zinc that characterize the entire system throughout its continental length. The value of the production is constantly growing, but possibly in no portion of Canada is the extent of the unprospected so vast as in this territory. This range has given to the Dominion its majestic system of mountains which constitutes one of the great tourist attractions of the world. The Rockies range in height from 10,000 to 13,700 feet, but the highest known point in Canada is Mount Logan of the St. Elias Range of the Yukon, that rises to an eminence of 19,539 feet, or three and two-third miles.

It may interest some to recall to mind that 100 miles west of the Cordillera, and only 25 to 30 north of the Peace River, is a plateau 10,000 square miles in area and about 2500 feet higher than the surrounding land. Though close to a much-navigated river, only one white man has ever crossed this plateau. There is a lake on it 60 miles long, never yet even mapped. The heights swarm with caribou, and it is called the Caribou Plateau. There is another north of Lake Athabasca. It is 47,000 square miles in extent. One point in it at the north is a paradise for the Indian hunters, who gather there every fall. And this plateau also only one white man has ever crossed; he was Samuel Stearne, who traversed it twice 145 years ago.

It is the tendency of people far removed in point of distance to form exaggerated notions of the outstanding physical features of a country, and as a consequence I find that Canada suffers somewhat in the eyes of the outside world from erroneous ideas as to its rigorous climate. The

Dominion is indeed a northern land, and there are undoubtedly large portions of its Arctic and sub-Arctic territory within which the ordinary pursuits of life cannot be followed, by reason of the shortness of the seasons and the extremity of the climate; but the proportion of this territory and its effect in the estimation of the capital assets of the country are not nearly so great as is the prevailing impression. While the atmosphere as a rule grows colder as one proceeds northward, it must be remembered that the elevation of the country as well as its latitude must be taken into account in arriving at natural conditions governing climate. The elevation of the great body of our western country, for example, is thousands of feet lower than it is south of the United States boundary, and as a consequence the climate moderates as the lower levels are reached. It is stated on competent authority after careful study, that spring in the Peace River district (a territory of vast extent and fertility), in Central and Northern British Columbia and in Alberta, begins earlier than it does further south, and indeed advances south-east at the rate of 250 miles per day. Summers in the north-west are warm, and, as civilization advances, are not unduly short. Not only is the elevation lower—accounting in part for this phenomenon—but the mountains on the north as a rule are also much lower, and through their passes blow the Chinook breezes from the Pacific. The presence of almost innumerable lakes, many of them of great extent, throughout the north-west exercises as well a moderating influence on the climate.

The value of Canadian agricultural production, as well as its promise, is too well known to justify elaboration by me in this address. It is my purpose, though, to say a word as to certain of our resources with regard to which less definite impressions exist.

The coal deposits of Canada, while very far indeed from being fully explored, may now be estimated on a reasonably safe basis. So far as discovery has yet proceeded, we do not appear to possess anthracite coal in quantities comparable with those enjoyed, for example, by the United Kingdom or by the United States of America. We have, however, even of this variety, very substantial quantities. Located in Western Alberta, in the basin of the Cascase River, are deposits of anthracite estimated at 400 million tons. The total tonnage of anthracite in Canada appears to be approximately two thousand one hundred million. This is less than 20 per cent. of the anthracite tonnage estimated to be in reserve in the British Isles.

Coming to bituminous coal, the reserves of Canada are undoubtedly immense. The Province of Alberta alone, which is indeed a territory veritably charged with this mineral, is underlain to the extent of about 30,000 square miles with bituminous and semi-bituminous coal. Nova Scotia is, of course (as yet at all events), our greatest coal-producing province; and indeed Canada, measured by the standard of production rather than of reserve, cannot be said to stand as yet in the front rank of

coal countries. War conditions, or war necessities, are proving the mother of invention, and there can be little doubt but that the not distant future will see a very marked advance in coal mining. For the present it may be worth while, although by no means in the nature of new information to the members of this Society, for me to emphasize the stupendous reserves that lie in the bosom of our Dominion. Including only anthracite and bituminous coals, the best estimate available places the reserves of Canada at 285,000 million tons. Including lignite also, which is already in use, and for the greater use of which the Provincial and Dominion Governments are organizing, the total deposit may be placed at 1,234,000 million tons. This constitutes about 70 per cent. of the entire coal reserves of the British Empire, and of this more than four-fifths is in the single province of Alberta. The British Empire is said to contain one quarter of the coal reserves of the world. Much of this great natural wealth in Canada is inland, and may not experience rapid development, but, on the other hand, there are vast supplies close to water transportation on both the east and west shores that will share more and more in the world's trade. Another feature of importance is that not a single province is without its supply, and only a limited though thickly populated territory in Central Canada is far removed from this source of fuel and power.

Closely allied in modern commercial calculations with the question of coal is the subject of water-power. Here the Dominion stands in a position of great natural advantage, and what is of perhaps more immediate consequence, in a position of relatively rapid present development. It is a matter of much interest as well as of stupendous importance that the great hydrodynamic powers of Canada are located profusely throughout the very territory which does not enjoy the advantage of coal deposits. Throughout the Provinces of Southern Ontario and Quebec, and of Manitoba as well, are to be found as superbly placed and as mighty water-powers as exist in the world. It is not worth while in our time to discuss all the water-power resources of the Dominion, for many of them are situate in districts that for the present are without substantial population; but confining ourselves to the peopled parts of Canada, a fairly thorough survey has been made by competent engineers under the Water Power Branch of the Federal Department of the Interior, and this survey places our potential commercial water-powers at a capacity of 18,805,000 H.P. Of this total capacity there has already been developed 1,735,600 H.P., or a little less than 10 per cent. Such a development is, in my humble judgment, creditable to Canadian resource and Governmental activity, especially when regard is had to the paucity of population and to the short period over which operations have proceeded. The water-power development of the Province of Ontario and its control are achievements from which every Canadian can take confidence and hope. Of this 18 million odd potential H.P. in the settled portions of Canada, a little less than 6 million is in the Province of Ontario, and 6 million is in the

province of Quebec. The falls are all within easy transmission distance of the great industrial centres of these provinces, and, properly directed and co-ordinated with our other fuel resources, constitute the magnificent basis upon which the future industrial progress of these great provinces rests. A single horse-power is estimated for power purposes as of the fuel value of ten tons of coal. There is being used in Canada in the form of water-power the equivalent of an annual consumption of 14,600,000 tons of coal, or not far below our present coal importation. Coal is destructible and exhaustible; water-power is indestructible. Among the exports of Canada to-day is an item of 275,000 H.P. or the equivalent of practically three million tons of coal, which amount almost represents the total anthracite importations into the Dominion. Our exported power is being utilized by the United States industries for war purposes. Perhaps I might be permitted to place on your records a table showing the available and developed power in the settled portions of each of our respective provinces, viz.:

Province.	Power available.	Power developed.
Ontario	5,800,000	789,466
Quebec	6,000,000	520,000
Nova Scotia	100,000	21,412
New Brunswick	300,000	13,390
Prince Edward Island	3,000	500
Manitoba		76,250
Saskatchewan	3,500,000	100
Alberta		32,860
British Columbia	3,000,000	269,620
Yukon	100,000	12,000
Total	18,803,000	1,735,598

An interesting feature of this development is the fact that 78 per cent. of the total water-power now in use is publicly controlled. Of the balance, 14 per cent. is consumed by pulp and paper manufacturers situated mainly at more remote points away from industrial centres, and the remaining 8 per cent. is used in electro-chemical and similar processes. The electro-chemical industry appears to be due for rapid advancement in Canada. Its products at the present time are, I believe, almost wholly used for war purposes. Indeed, through Provincial and Dominion control, priority is given to war productions in the allotment of all our developed water-power. The Dominion stands second in the world, and not far below the United States, in the wealth of its hydro-dynamic natural resources. There are no three countries in Europe whose water-power potentialities added together would equal those of Canada. When it is considered that one-fifth of the railway tonnage of the Dominion consists now of the haulage of coal, some idea may be

obtained of the importance of our water resources in the commercial expansion of our country.

I would not venture to discuss before scientific men any explanation of the extraordinary abundance of our waterfalls, but, briefly put, my rough understanding is this: the phenomena of the glacial age in their retreat from the surface of the globe lingered last in its northern zones, and these waterfalls are the immediate progeny of those phenomena—the liaison between us and those far distant times.

If there is one possession of the Dominion more than another the value of which we have failed to realize ourselves, it is our forest wealth. There are no good guesses as to the extent of this resource, for the reason that forest exploration even to this day is singularly incomplete. The best qualified experts we have, while reluctant to hazard an estimate, place the extent of tree-covered territory at between 500 million and 600 million acres, of which perhaps 300 million acres are covered with merchantable timber. The ravages of fire accompanying the progress of settlement have devastated vast areas and destroyed a deplorably large proportion of this element of our national capital. It is true the burnt-over mileage is in process of reforestation, but the rate of progress is slow. However, through the activities of provincial and federal authorities, organization for the control, conservation, and proper utilization of our forests is becoming more and more efficient. The forest area is spread over the length and breadth of the Dominion, except perhaps in the very farthest north, and is everywhere except there in quantities and locations commercially valuable. It is noteworthy that even in the older provinces of Nova Scotia and New Brunswick the greater portion of the land is still tree-covered, the area in Nova Scotia being two-thirds of the whole, and in New Brunswick about four-fifths. The Province of Quebec is the most richly endowed; and so great is the entire supply that the utilization of our forests for lumber, fuel, pulp, and paper, though substantial and great enough to constitute one of the foremost of our exports and sources of wealth, is even under present conditions of administration very substantially less than the annual increase from natural causes alone. The pulp industry of Quebec in particular is extending with great rapidity, but as yet it is estimated—though with a degree of uncertainty due to the inadequacy of our investigations—that the depletion by use is not more than one-sixth of the natural growth. In the farther western provinces the proportion will be less. British Columbia has, as is well known, an empire of forest wealth. The trees in that province reach majestic proportions and attain a venerable age. Douglas fir, which is the principal variety, grows at times to a height of 300 feet and to a diameter of 15 feet. It is true that these dimensions are exceptional, but elevations of 250 feet and diameters of from 6 to 10 feet are common. The Sitka spruce—a variety which flourishes along the coast—has proven of superior value for aeroplane production, and is now being utilized in

substantial quantities for that purpose. The large islands on the Pacific coast are especially fortunate in their forest possessions, and the annual growth in that region, due to climatic and soil conditions, is much more rapid than in the other portions of the Dominion. For the purpose of forest preservation, silviculture and reforestation, forestry branches have been established by the Dominion Government and by most of the provincial administrations. A total of 159 million acres have been allocated to forest reserves, and over these areas the organizations of the various Governmental branches exercise supervision. Their activities are directed first to the protection of their respective reserves from forest fires, and in this respect have, particularly in recent years, achieved a considerable degree of success. The total number of fires during 1916 was 891 as compared with 1455 in 1915 and 1986 in 1914. The total area burnt over in the last fully recorded year was 116,310 acres, of which area only 2000 acres could be classed as merchantable timber. The Dominion organization also oversees lumber operations and wood cutting within other areas, and in the reserves has commenced a system of reforestation, though as yet on a modest scale. Nurseries have been instituted, and last year some seven million trees were distributed for planting free of cost to the farmers on the western plains.

If one of my listeners takes up a railway map of Canada he is impressed with the comparative narrowness of the belt of settlement that stretches across the 3500 miles from ocean to ocean. There appears to be an almost illimitable area of barren land—and indeed barren land it is geographically called—stretching away toward the vastness of the Arctic. There is one feature, however, of this territory to which it is fitting now to call attention. The land is by no means barren. It supports a wealth of plant and animal life, and no barren land can do that. The few explorers who have visited these regions, commencing with Stearne in the latter half of the eighteenth century, report very enthusiastically not only on the splendour of its summer climate, but on the richness in many parts of its plant and animal production. Its fur resources are enormous, and it is not improbable that the animal product of this territory will yet become commercially valuable. All explorers unite in affirming that the country is literally covered with enormous flocks of caribou. Mr. Thompson Seton declares that at a most conservative estimate there must be 30 millions of these animals inhabiting the western northlands. They are said to be easily domesticated. They weigh from 100 lbs. to 400 lbs., and when slaughtered the meat equals the best of beef. It is not impossible that after-war conditions as to meat supply and as to transportation will direct attention to this resource. Musk ox also are present in large numbers. The black fox is, of course, already a subject of domestic production, and fur-farming promises to constitute a stable industry of the Dominion.

A word now as to Governmental control. Canadian industrial expansion

has proceeded chiefly along lines of private initiative and enterprise. The stimulus of individual profit remains in almost every field the most potent force in our development. Every motive of honour and of interest enjoins that that stimulus be not blighted or destroyed. There is no spirit of confiscation abroad among Canadian people or Canadian public men. Such of our resources as from time to time pass from public ownership into private hands are thereafter subjected to control only that waste and the locking-up for selfish and speculative ends may be avoided, and by no means that their legitimate earning power may be checked. The dictates of wise policy have suggested that our invaluable water-powers—an asset of a clearly distinctive character—should be to the utmost possible extent not only state-owned and controlled, but state-developed and operated. All the arguments that go to support Government monopoly apply with peculiar force to water-powers. The long years that are required in the production of a forest crop render forest management also a proper sphere of Government activity. But private enterprise has and will have in Canada abundant opportunity. No just right of invested capital is now being disturbed or will be disturbed. While our people realize that in the evolution of industry the tendency is, in many spheres at least, for the units to collect and grow larger and larger, ultimately maturing by slow degrees into state proprietorship and operation, still, while that is realized, there is no spirit of rampant or headlong socialism in possession of the Canadian mind. There will always be British fair play. Capital is as safe in Canada as in any country on earth.

I have recounted some of the material resources to which the Dominion is heir, but I would fail indeed to represent that country if I did not tell you of another inheritance that she prizes more than all the rest: the full free stature of nationhood, with equality of citizenship and equality of opportunity into which she has grown under the ægis of the British Crown. That heritage is the Ark of the Covenant to Canada as to every British community, and every piece and pillar, every line and letter of it she will guard with her life. And let me say this more, and I am a proud man to say it now at the very hour of destiny when the truth that I express means the most: Canada is a faithful child of these islands. Crossed with the blood of your great ally France, and influenced industrially by the almost overwhelming current of the vast Republic that surges to the south, Canada none the less is British, sternly, dependably British. In feeling, and in thought, in sentiment, in aspiration in the sense of her mission in this world, Canada is British—never more British than now. She believes and always wants to believe that Britain stands for real democracy. That country is unitedly, determinately democratic. She hopes and expects that out of the welter of this war of democracy, a war in which she strains, as in honour she must, every fibre and muscle of her half-grown frame—she hopes that out of it all there will come not so

much avenues to greater masses of wealth, but a wider area of opportunity, an improvement of living conditions, a higher general conception of public duty, a releasing of human energy for the pursuits of science and art—an advance for democracy all round over the whole universal line, and an advance commensurate with the cost.

Before the address the PRESIDENT said: We are here to-night to learn about the resources of that great and growing country Canada. The distinguished Canadian gentleman who will address us has already been introduced through the daily press to the British public (assisted by a most uncomplimentary photograph), and he has been described as a bright and particular star that has lately risen on the political horizon of Canada, and as a man who may yet some day be called upon to guide her destinies. Therefore I need hardly say that you will have an account of Canada from a past-master of his subject, and I can only ask you to give a most cordial welcome, not only to Mr. Meighen who is to address us, but to those other visitors from overseas who are kind enough to be present to-night.

(*The Hon. Arthur Meighen then spoke as above, and a discussion followed.*)

The PRESIDENT: I very much regret that Sir Robert Borden, whom we hoped to have with us to-night, has been detained by a meeting of the Imperial War Conference, and I am afraid we can hardly expect to see him now. I will ask Mr. Walter Long if he will kindly address you.

Mr. WALTER LONG: I have no title to represent Sir Robert Borden, whose absence we profoundly regret; I obey the commands of the President with even more than usual reluctance. I dislike, more than most people, intruding myself upon my fellow-countrymen. My own views about speeches are that I would walk many miles to avoid making one, and I would not willingly walk ten yards to hear one! Those are my general views. But I would gladly have walked many miles, if it had been necessary and no other mode of conveyance available, to hear the address to which we have listened to-night. Our President, when he was introducing Mr. Meighen to this distinguished audience, said it was possible that at some future time it might fall to his lot to guide the destinies of the great Dominion of which he is to-day a distinguished representative. I think the reflections to which we have listened, the description of the country which he has given us, and the declaration that he has so emphatically made as to what is to be the future of that Dominion, of her policy and of her people, must give us great confidence. But should that fate—may I so describe it?—overtake Mr. Meighen, the destinies, the future, and, above all, the honour of that great Dominion will be in the keeping of safe and strong hands.

Mr. Meighen told us that it would not be possible for him to give us anything new, anything of interest. The being in this audience who has not heard something new and of interest to-night must indeed be strangely constituted. It was like a fairy tale to sit and listen to that wonderful address delivered, let me remind you, without a note, giving us information of all kinds in regard to the Dominion and telling us many things that I am confident very few of us knew before. It was a wonderful story; and finishing, as he did, on that high note of love of country and imperialism, surely we sitting here must feel that, however strenuous may be the moment to which he referred, however difficult the conditions of the hour, we have something in this hall to-night

which is denied to the sovereign of the Empire which is our main foe. An address such as the one to which we have listened, and a story such as Mr. Meighen has told us, are impossible possessions for the German Emperor. They are the peculiar possession of the Sovereign of the British Empire. And I do not believe that in all the history of the world, of those empires which have ceased to exist, or of those nations which will continue to exist, I do not believe in all that long history, full of wonderment as it is, there is to be found a parallel to the story that has been told us quite simply to-night; the story of the British Empire at its best; the story of hard work in the past by those who were the pioneers of Canada's greatness and prosperity to-day; a story of splendid hopefulness for the future. Mr. Meighen said incidentally that this is a moment in this terrible war when the destiny of the British Empire is at stake and when the clouds have lowered for a time over us and give us cause for anxiety; but it has never disturbed our confidence; it has never weakened our supreme conviction that there can be but one end for this war: a victory which will give to free nations the opportunity, to which Mr. Meighen referred at the end of his remarks, of developing along those roads which he has described to us to-night with such wonderful eloquence and such marvellous advocacy.

It has given me profound pleasure to be here to-night and to listen to Mr. Meighen's address. It makes one proud to be an Englishman, if I may use the word without giving offence to somebody. And let me note this in passing: it is not the British citizen who hails from Canada or Australia, or New Zealand or South Africa who objects to the use of the word "Englishmen" in order to describe our race; it is the man who comes from Scotland—I leave out for the moment the Irishman, because he has an individuality of his own. But the Scotsman is the man who rises in his fury if you happen to talk about Englishmen. And yet it is a most remarkable thing that, go where you will in my profession—commerce—wherever there is a good thing to be got you will find that in nine cases out of ten the Scotchman gets it, and when he has got it nobody knows better how to keep it. In that case, why should a Scotchman object to the use of the word "Englishman"? I have always said if they would find a better word I should be quite content to use it; but I confess some of the words that have been substituted for the good old word "Englishman" are not at all satisfactory. It makes one proud to be an Englishman, to be present on an occasion such as this and to listen to an address such as the one to which we have been privileged to listen, a wonderful story of the British Empire, I believe in no sense exaggerated. For my own part, I am thankful to think that within the British Empire there is a great Dominion like Canada, and that in Canada there are statesmen with the breadth of view, ability, and courage possessed by Mr. Meighen.

Sir WILLIAM PETERSON (Principal, M'Gill University): I was not aware that it was the penalty of humble and anonymous attendance at a meeting of this Society that one might be in danger of being called upon to follow such an experienced speaker as Mr. Walter Long; but I must endeavour, in a few words, to meet the challenge, I came across the Atlantic with Mr. Meighen—hanging on, as it were, to the fringe of that wonderful galaxy of Prime Ministers of Canada, Australia, New Zealand, and Newfoundland, who crossed in the same steamship; and so I thought I would come round to assist at the birth of the lecture which I knew your guest was to deliver sometime in London. Like Mr. Long, I am proud as a Canadian citizen to have been present to hear the address given by one of whom Canada rightly expects so much in the time that is before us. It is right and proper that the Canadian

Minister of the Interior should be one of the highest, if not the very highest, authority on the resources of the Dominion; and I am sure that to-night's lecture is sufficient to have convinced all of you that there is no higher authority on that subject than the present holder of that high office. Mr. Meighen spoke of the opportunities which the Dominion is to enjoy in the coming time, and he gave ample reason for confidence and hope that her future is to be even more solid, even more distinguished than her past. The subject might be treated from an even wider point of view—a point of view you know something of. The problem that is before us is that of exploiting to the fullest extent the resources of the whole Empire, of finding new sources of wealth, stimulating new industries, facilitating transportation, so as to make the Empire more self-sustaining. So far as Canada is concerned, we know that her commercial and manufacturing and industrial future is very safe in the hands of that Coalition Government of which Mr. Meighen is so distinguished an ornament. But apart from that, if I were to think of any single topic on which to address you, it would be something rather distant from the object for which we are gathered together to-night. I used to belong to a Geographical Society myself (probably early last century !), the Royal Scottish Geographical Society: I am not sure I was not even President of the Eastern District of that Society. Now, I don't mean to take any notice of the insults that are always heaped upon Scotsmen, but I am going to say this: that in the coming time there will be other problems before all the countries of the Empire of a different kind from those which Mr. Meighen has expounded to us to-night. There will be, in particular, the problem of how to make the most of the marvellous opportunities of a material kind that lie before us. I am proud—and I say this as Principal of the M'Gill University—to remember that in Canada, as in England, science and industry are going hand-in-hand, and that we who are engaged in educational work are doing our best to show how in the most sympathetic and in the most fruitful manner possible the opportunities of further co-operation in regard to the material elements of prosperity are being more and more fully developed from time to time. I do not need to prove that proposition in detail. The future will show that a great deal of the prosperity of the Dominion in the coming time will be due not only to industry and commerce and manufacturing, but to the co-operation of those who in another way—in our scientific, technical, and other institutions—are ready to work hand-in-hand with our men of action in order to enable them to pursue the development which is their chief goal and aim. That, I am sure, is possible. But it has certain conditions, certain limitations and responsibilities, and that is that in Canada, as everywhere, education must be put in the very forefront of the ideals and aspirations of the people as a people. It is not for me to say a single word in depreciation of Canadian education, but I will say this: that Canada will have to wake up if she is to keep pace with the wonderful improvements which are being made in the United Kingdom under the present Ministry, and especially under the Right Hon. Mr. Fisher's guidance in that department. In the presence of the Minister of the Interior in Canada I am going to submit to this audience one almost foolhardy suggestion. By what I think a most regrettable provision of the Constitution of Canada, the Government of which Mr. Meighen is a member is not supposed even to know that education is being carried on in the Dominion. Education is remitted by the practice of the Constitution of the country to the provincial Governments. Now, against that I have always protested. And I am hopeful that if lawyers take the subject wisely in hand, as my honourable friend is so

competent himself to do, they will make the discovery which I made long ago in Canada: that the intention of the British North American Act was to remit education only in the sense of common school education to the various provincial Governments. Not a word is said in the B.N.A. Act about that higher education which is of such importance to the development of industry; not a word about University education; not a word about the various developments in which a nation must take part if it is to stand in the forefront of modern civilization and progress. I prophesy that the day will come when the Dominion Government, recognizing that the educational progress of the Dominion is impossible without the co-operation of the Federal Government, will say to the various provincial Governments in Canada: Do not imagine for a moment that we are going to infringe upon your autonomy, but we want to help to bring into operation in these seven sister provinces the fullest possible educational development; and we, the Government of Canada, whose resources are growing every day with the exploitation of the soil, the minerals and all the other wealth of the country, will supply you with ample funds for the purpose of carrying on that higher education on which the prosperity of the country so greatly depends. That is, of course, merely prophecy, but with it I venture humbly to take leave of this distinguished audience.

Mr. ROWELL (President of Canadian Privy Council): Those of us who come from Canada—a large territory more or less sparsely settled—to a great city like this with a dense population, have had the thought that we might move around and visit a few places without being seen. We find that even in London the Chairman's eye may see us, and we are not safe in going anywhere unless we are prepared to be seen. I am very glad to have had this opportunity of being present at so important a meeting of this historic Society, and of hearing the review of Canada's natural resources by my colleague Mr. Meighen. It needs such a review occasionally to remind us of the great heritage that Providence has placed within our reach, and as Canadians we are very grateful for the country which has been entrusted to us for development. As Mr. Meighen has pointed out, our natural resources are very great indeed, but, as he suggested in his closing words, we do not believe that our country's future depends so much upon the possession of those natural resources as upon the type of citizenship we shall develop in the days that lie before us. We have a climate some people think rather rigorous. It certainly is not so hot that people can gain their living without work, as the inhabitants of some southern climes may do; nor is it so cold that people cannot earn a living by reasonable work, and at the same time enjoy the comforts of modern civilization. We have such varieties of soil and climate as should develop a nation possessed of a great variety of talents and capabilities. The development of our immense natural resources, the conquest of nature, will make a great demand upon our energies and call for the cultivation of all the characteristics of a strong, progressive, and resolute race. But we recognize that more important than all other considerations will be the moral character of the people of the country; we realize, in that new country, that the greatness of these islands rests vastly more upon the type of your citizenship than upon your resources. It is the ambition of the Canadian people to build up on their half of the North American Continent a strong, vigorous and intelligent people with moral and spiritual ideals and standards worthy of the best traditions of our race. Geographically Canada stands midway between Europe on the East and Asia on the West—Europe which has led the world during recent centuries, and Asia, populous, ancient, mystic

and slow-moving, but on the eve of marvellous changes. Fronting on the Pacific as our western border, and on the Atlantic as our eastern, we hope that we may have the opportunity of playing some real part in binding together the East and the West, and of helping to form the bridge across which the civilizations of Europe and Asia may join hands: not to destroy each other, but to co-operate, when this cruel war is over, for the benefit of our common humanity. We have to the south of us that other great branch of the Anglo-Saxon race, estranged for many years from the people of the Mother Country, and we feel that here too we have an important rôle to play. We understand our American cousins, perhaps, better than you do. We understand the people of the Motherland better than our American cousins do; and in this reunion of the different branches of our race in the great struggle in which we are engaged, Canada may play an important and helpful part. We trust that Canada, in close and sympathetic touch with each, may help to bind together these two great branches of our race in a solid and permanent union for the advancement of the cause of freedom and civilization in the great days that lie before us.

[Dr. MILLER spoke on the mineral resources of Canada, but the report of his speech, sent to him for revision, had not been received by us at the time of going to press.—ED. *G.J.*]

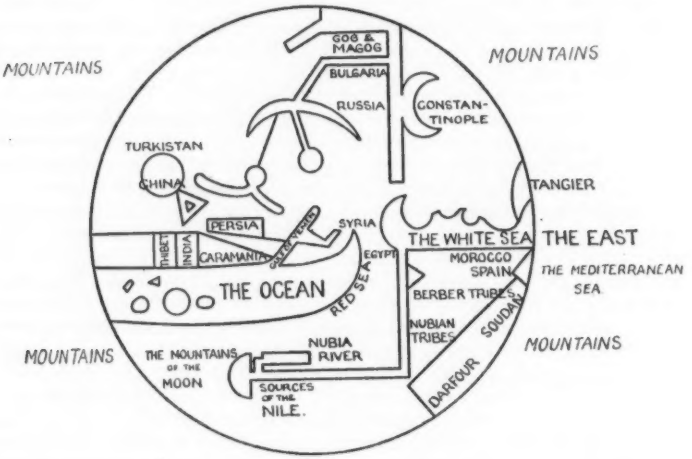
The PRESIDENT: I have but very few words to say in conclusion, and I should like to say those words for our Society. No one can have listened to the thrilling account which Mr. Meighen has given us of the resources of Canada and the energy of the Canadian people without being impressed with the conviction that in the future regeneration of the world, in the evolution of nations, as Mr. Meighen puts it, Canada is bound to bear a very great part. We geographers have long been acquainted with Canada from the geographical point of view—years ago, when in happier times Canada has been the happy hunting-ground of generations of geographers. Some have sought out the extreme north-west—the valleys of the Yukon and Mackenzie rivers; others have spent a healthful mountaineering holiday in the Rockies; but all have come back with the conviction of the greatness of Canada, of its inexhaustible resources, and an appreciation of the hospitality extended to them by the Canadian people, with the freedom common amongst all geographers which no width of the Atlantic waters will ever be able to diminish. I think that perhaps it is because we geographers are in the habit of expecting from our explorers those qualities of courage, devotion to duty, and the spirit of self-sacrifice without which the great secrets of Nature are not to be wrested from her, that we are quick to recognize those same high qualities in our Canadian cousins, which have been exhibited, not only in their own particular field, the field of industry and energy and the development of civilization in their own land, but more especially in their splendid achievements during this war. I believe that when history comes to be written—if it is ever fairly written—the story of the war will be an epic in the life-story of all English-speaking nations alike, and it will ultimately be the most extraordinary history that ever was written. With these few words I will offer for the Society a humble tribute of admiration to those Canadian gentlemen and distinguished visitors from overseas who are with us to-night, for all that they stand for here—for the greatness of Canada, and for the devotion of the Canadians to the great cause which fills all our minds at present. In future I trust that, as the last speaker has said, there will be but one ideal between us, and that our watch-word will be "Unity." With that, I will ask you simply to join in a most cordial vote of thanks to Mr. Meighen for his most suggestive and interesting address.

THE ACHIEVEMENTS OF FRANCE IN MOROCCO

Mr. J. M. MacLeod, H.B.M. Consul at Fez

Read at the Meeting of the Society, 13 May 1918.

DURING the last few minutes you have been looking at the map on the screen, and may have been wondering what it was. It is a translated copy of the Map of the World in use formerly at the Karuin College at Fez—on the rare occasion when a lesson in Geography was given there. Whatever its merits from the geographical point of view, it depicts and embodies with wonderful exactness the aspect which the world presented to the Moors of the interior a generation ago, when foreigners first began to reside regularly amongst them.



Before the French occupation much work had been done in Morocco, indispensable work of an importance hard to measure. It laid the basis on which all subsequent work had to be built, and in many directions provided the elements and instruments by which it had to be accomplished. In science, travel, trade, philanthropy, and politics it was not however, the work of Frenchmen alone but of many others as well, our own fellow-countrymen largely included. To cite just one instance: that monument of erudition, the most valuable work on the country then existing, the 'Bibliography of Morocco to 1891' by Sir Lambert Playfair and Dr. Robert Brown, was brought out by the very Society I have now the honour of addressing. All this, however, is beyond our present subject. No one has acknowledged more warmly than has the Resident-General himself both the value of that old work in all its spheres and the

influence exercised by almost all the Europeans in the interior, few as were their number, during the thirty years preceding the occupation, the influence, that is to say, under which this old map fell into discredit first and then disuse. It was under that influence that first the tax on the sale of slaves and later the public slave market at Fez, for example, disappeared—the more readily that the extension of French influence to the east and south of Morocco closed up the principal sources of supply for that traffic.

The inhabitant of the interior of old Morocco, that is to say Morocco before 1911, when the penetration by France began on a large scale, dwelt in an isolation from the rest of the world—even of the Morocco world—which is difficult indeed for the new-comer to-day to realize. Distances were measured by hours' journey—on foot, or riding at a foot pace following caravan tracks over the open country. Twenty-five to 30 miles a day, under the driest conditions, the normally energetic traveller might hope to accomplish. At 15 miles a day the high Moorish functionary or foreign ambassador, at 25 miles a day the more modest traveller, at 40 to 50 miles a day the letter courier, made their way through the country; made their way, that is to say, if the weather were not too wet, the tracks not too deep in mud, the rivers not unfordable, or the ferries not unworkable, nor the intervening tribes unfriendly to each other or to the Sultan.

Over about two-thirds of the country such unfriendly tribal attitude was chronic, was part of the order of things, and tacitly accepted by everybody—Sultan included. Consequently if a stretch of such country (the so-called "Blad Siba") intervened between him and his destination, the traveller, native or foreign, perforce moved very circuitously; for example, from Fez to Marrakesh one always went by way of Rabat. From Fez to Ujda natives could sometimes go directly and sometimes they could not. If at all in a hurry, or wishing to travel in the utmost security, they went to Tangier and thence by sea to Oran, and then by land to their destination. When no safe circuitous route existed the native traveller resorted to payment to local tribesmen of safe-conduct money ("sattat," an institution not unlike the blackmail of the old Scottish Highland border) towards securing himself and his belongings from molestation. Of Europeans such districts seldom or ever saw any. The few Europeans, that little band of heroes whose real adventures are as enthralling as any work of fiction, who did make such journeys of their own free will, numbered no more than perhaps a score in the hundred years preceding 1912. I say of their own free will, for I mean travellers, explorers, and the like, and not fugitive renegades from Algeria or from the Spanish "Presidiös" of the north. Formally, Fez and Marrakesh were fourteen days distant from each other. At a great price for extra exertion one could by fast runner "courier" (if the weather, mud, tribes' behaviour, etc., permitted) send a special letter and get a reply from

Marrakesh in eleven to thirteen days, or from Tangier in six or seven days.

A hedged enclosure wherein to encamp was all the accommodation afforded to the traveller in the country, an empty house and stable or a native caravanserai all that was available in the towns. Except the little state coach which carried the Sultan smoothly over the palace courtyards to the mosque on Fridays, or jolted after him outside the walls on festivals, not a wheeled vehicle was to be seen.

No telegraph existed, either wire or wireless, and of course no telephone. Nor was there any Arabic newspaper. Under such conditions the isolation for the few Europeans who lived in the interior may be imagined. Their education, books and newspapers, letters and visits to Europe; the occasional visits of strangers; and the society—the very cosmopolitan society, as at Fez, for instance, where a foreign community of some seventy persons was of at least six nationalities—mitigated the isolation to some extent, and it indeed often gave interest and charm to the life. This modified isolation had lasted, however, only thirty years—had affected but one generation of those Europeans' lives.

The isolation of the Moorish population from Europe, however, had been a hundredfold more complete, had been aggravated by everything which racial and religious antagonisms could engender, had lasted four hundred years, and had impressed the minds of sixteen generations. In the cities life socially, economically, and administratively was that of Mediæval Europe, but without its good humour. All was melancholy, suspicion, and greed, and sourness. The children of Fez had scarcely a toy. They had to be taught to play! In the country the population was simply in the tribal stage of social development.

Viewed from a distance it all seemed fair and pleasant enough. Nearer approach, however, presented a strange medley of bewilderingly ludicrous contrasts and anomalies. Sheer comedy or farce seemed the tone and nature of everything. But a longer stay than a few months never failed to reveal the hideous tragedy underlying the scenes whose outward beauty or humour might previously have impressed the traveller.

The Government was described by the late Sir John Drummond Hay as "a kingdom of fishes of prey; one wherein the biggest one of all lives by devouring the next biggest, those in turn the smaller, and so on down to the minnows feeding on the almost inanimate larvæ." Sir William Kirby-Green, Sir John Drummond Hay's successor as British Minister, whose experience of Morocco was also long and minute, likened the Government to "a filthy marsh with a beautiful tree luxuriantly growing in its midst."

The tragedy was no less deep and wide in the social life and surroundings and in the physical state of the Moorish populations, at the time when the transformations we shall relate were commenced.

Trade with abroad showed, indeed, some evidence of life, and even of

slow and precarious growth; but in every other sphere, social, intellectual, industrial, and artistic, stagnation and decay were no less prevalent than they were in that of government.

How complete and general was the ruin will be seen when we look at the remains which have been revealed and at the sweeping and elementary nature of the various measures needed to restore country and people to their ancient vigour. To understand these measures let us look for a moment or two at the map of Morocco of to-day. You will notice that, physically, it is divided into two acutely different areas: that which lies north-east, west, and south-south-west of the Atlas, and that which is east and south-east of that huge mass. The former, watered by the clouds and cooled by the winds of the Atlantic, is green, fertile, and in climate temperate. The other, almost rainless and riverless, and scorched by the hot desert winds of the Sahara, is brown, arid, and for many months of the year torrid.

Politically the Moorish Empire is in principle one, but is divided into three parts—the so-called zones. First, there is the tiny international zone of Tangier, at the north-west corner. Then there is the Spanish zone, mostly on the north, but including also a small portion of the extreme south. The remainder is the French zone, with which we are now concerned. Strange as is this political situation of the country, the physical and ethnological story which the map depicts is no less paradoxical. As it is separated by seas from Europe, and joined by land to Africa, we are apt to regard Morocco as belonging to the African continent, and its peoples as Africans, or, at any rate, as Asiatic immigrants.

The real African continent, however, begins at the Atlas Mountains only, and Morocco north thereof is really a part of Europe, detached at some remote age, but European in its elements and features (as are also Algeria and Tunis). Sir Harry Johnston has well described these States as forming a European island at the north-west of Africa. The same may be said of the inhabitants. A small proportion—probably less than 5 per cent.—are negroes, or partly of negro descent, slaves brought from the western Sudan and their offspring; but the rest, whether Arabs or Berbers or Jews, belong to the Caucasian branch of the human race. Moreover, year by year it is becoming more and more clear that the Arab invasion itself—which gave all north-west Africa so Asiatic a colour—was the work of comparatively small numbers of people, and that the immense majority of the inhabitants of Morocco, even of those who speak Arabic, are really Arabicized Berbers and not of pure Arab origin.

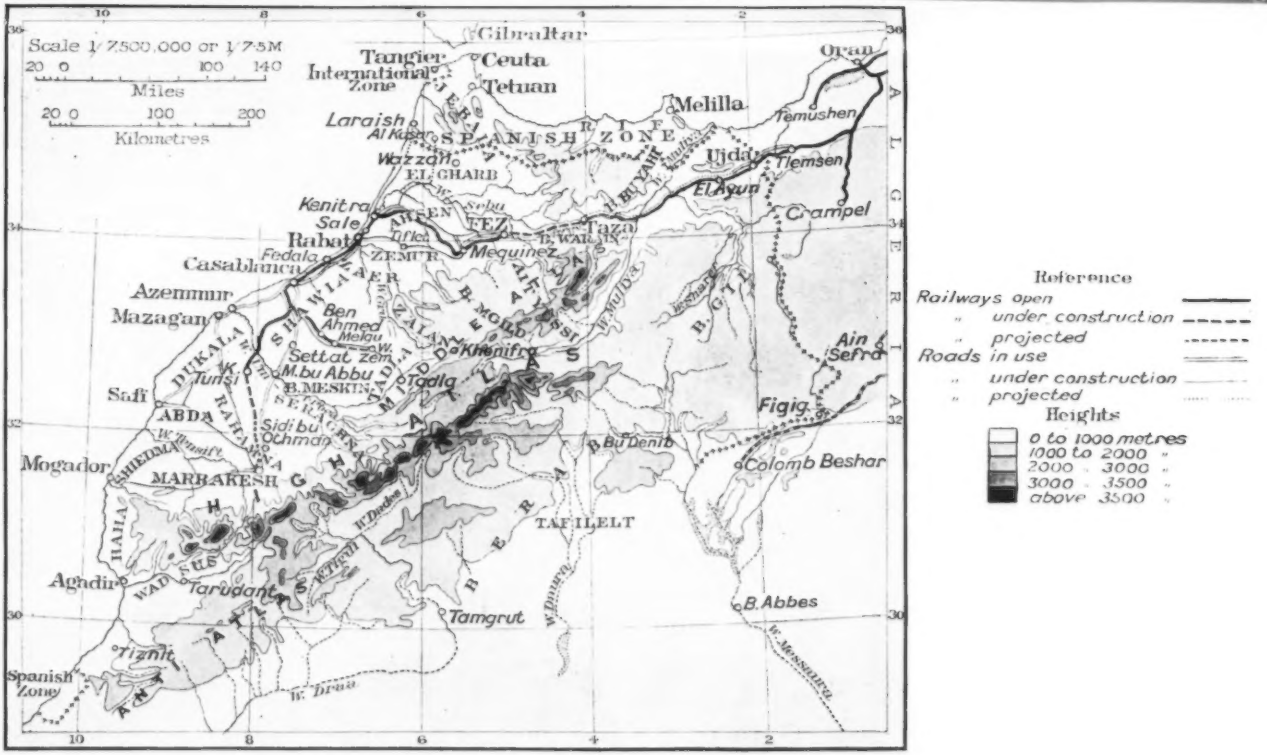
Into the misty controversy on the precise origin of the Berbers I do not propose to enter. For all practical purposes the results of anthropological examination of these people show indisputably that they are Europeans, *i.e.* Caucasians, and in the main descended from the people

who inhabited north-west Africa in Roman times. I want to call close attention to these points, however, because they are of much importance in understanding the past, and of still greater importance and encouragement when we think of the future of the French zone of Morocco. The restoration of Morocco to Europe may therefore be regarded as the first great consequence of European intervention, and the various achievements of France in carrying out her share of this work will be seen as we proceed with our study of the map.

From 1907 till 1911 France had been in occupation of Ujda and of Casablanca and their immediate neighbourhoods. In the first half of 1911 the utter breakdown of the Sultan's Government (that of Mulai Hafid) led to a strong French military force proceeding to the Fez Provinces; and this was followed by a Spanish occupation of Laraish and Alkasar. Late in the year the Powers assented to these occupations becoming permanent and extensible within the limits of their respective zones. In the meanwhile the Sultan's financial indebtedness to and dependence upon France had increased enormously, while at the same time agitations and disasters multiplied, and the Sultan's control became weaker and weaker, until finally, in March 1912, this zone was formally declared a French Protectorate. Then began the various activities to which I shall now refer.

To get an idea of the situation and problem in May 1912 let us now look at this map. The white area represents what is, and was, normally law-abiding country, *i.e.* paying imposts and obeying governors appointed by the Sultan. It is locally called "Blad Makhzen," that is to say, "Government land." The dark area—by far the larger, though generally less fertile and less populated—shows the lawless land, the so-called "Blad Siba," or land of chronic rebellion.

Far from being one nation, these were two sets of tiny nations, who made peace and war, and formed alliances with each other or with the Sultan. The chief art of internal government, such as it was at the Moorish Court, consisted very largely in playing off one tribe or group of tribes against another, and thus preserving for the Sultan, if not a real, at least an apparent preponderance of power. In this the Moorish Court became so adept that it is quite easy to understand their success for so many centuries in playing off the foreign nations, regarded by the orthodox Moor of old as just so many, but unthinkably numerous "Siba" tribes not yet controlled by the Head of the Moslems. Every convulsion leading to a change of dynasty or the like had in times past been the result of invasions of the "Makhzen" by the "Siba" tribes. To keep and to increase control of the one set of tribes, without convulsing the other, was the whole problem of interior government that the Sultan had to solve. This naturally became the chief Moorish problem of France also when the Protectorate was established.

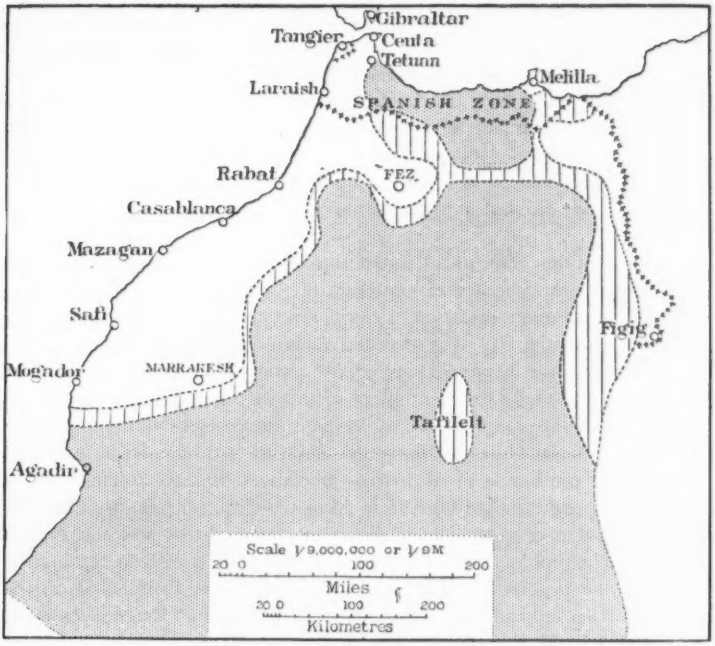


SKETCH-MAP OF MOROCCO, TO ILLUSTRATE PAPER BY MR. J. M. MACLEOD

STREET IN OLD RABAT

RUE SIDI-FATAH, RABAT

The plan in view was that the French control would be introduced by slow degrees from the top, and in filtering downwards would meanwhile simply carry on and improve the existing administration. Unquestionably, however, great differences of opinion as to how this should be done existed among the French themselves on the spot, the civilian element in the person of the French Minister and the military element represented by the Commander-in-Chief of the army of occupation being



in acute disagreement. Intriguing, self-seeking proceedings on the part of the Sultan himself (Mulai Hafid) added still more to the dangers ahead.

Differences and intrigues alike were ended by the outburst of 17 April 1912, the since famous Mutiny of Fez. Some 3500 out of the 5000 Moorish troops then at Fez suddenly revolted, massacred 24 of their officers, about seven civilians (including two French women and a French priest), and some sixty Jews, and looted the regimental stores of small-arm ammunition. Joined by mobs from the city, they then sacked the Jewish quarter and various foreign establishments, including a French bank, and besieged the remaining Europeans in the Consulates quarter. Suppressed

RUE SIDI-FATAH, RABAT
STREET IN OLD RABAT

in the city, the revolt spread amongst the tribes to the north and north-east.

On May 25 the Resident-General, General Lyautey, arrived—duly invested with all necessary powers both military and civil, but accompanied only by his personal staff. That night a furious attack was made on the city. Three gates and about a third of the town were captured, and it was only after some sixteen hours of the bitterest fighting that the rebels were driven out. A further attack on the city—on the day of May 28—was delivered, and seemed likely to prove the most dangerous yet experienced, but though the rebels captured the heights on three sides of the city and were some 25,000 strong, it was not pushed home. Apparently their losses during the day had discouraged them, and, however that may be, they decamped during the night, and were finally scattered on June 1 by General Gouraud, later so celebrated at the Argonne and in the Dardanelles, where he commanded the French troops with great distinction until all but mortally wounded.

Time will not allow of a detailed description of the military, political, and administrative measures—creation of municipalities; restoration of native functionaries; cessation of courts martial; withdrawal of indemnity demands from the city; the detested Sultan's abdication, which he had volunteered in the hope of being offered some great price to remain, but which was accepted; the election of a new Sultan, and much more. As fast as these problems were solved in the north a huge one loomed up in the south. Mulai Hiba esh Shinguiti—Shinguit is on the desert border at the farthest south-west of Morocco—proclaimed himself Sultan, invaded the country, and installed himself in Morocco City (Marrakesh), where he made prisoners of a number of French military officers and the French Consul. The problem then was how to dislodge Hiba without causing the death of the prisoners at his or the mob's hands, or their being carried away by Hiba in his flight. On September 4 a column was concentrated at Sok-el-Arba by General Lyautey and was despatched on the 6th under Colonel—later General—Mangin. Marching 41 miles in thirty hours—inclusive of six hours' fighting—this column swooped on the Hibist forces, some 6000 strong, at Sidi Bu Othman, inflicted a loss on them of 2000 killed and wounded, and put the rest to headlong flight. A light column pursued them to Marrakesh overnight and entered one side of the city while Hiba rushed out at the other. In the surprise and panic so successfully produced the prisoners were left unmolested, and in the morning were in the arms of their deliverers. It was a fine military achievement and of the greatest local value, for it established the Franco-Moorish authority as firmly in the south as General Gouraud's victory on June 1 had fixed it in the north. You will not be surprised if I remark that this is that same General Mangin whose feats at Verdun, including the recapture of Forts Douamont and Vaux, all the Allied World has acclaimed.

The French military position at this stage, in September 1912, was occupation of the coast ports and their neighbourhoods, of Ujda and its neighbourhood, of Bu Denib and its neighbourhood, of Fez, Mequinez, and Marrakesh and their neighbourhoods, with thin lines of communication between those cities and the coast, lines averaging about 100 miles in length. Administratively the Protectorate's situation was that in the loyal country (the "Blad Mekhzen") the native local functionaries from governors downwards, that is, those in direct contact with the population, were again ruling as usual, and ordinary traffic and life proceeded normally. To outside spectators it may seem strange that these populations should have accepted the new *régime* with such alacrity; but three reasons fully account for it. The old *régime* was so atrociously bad that the governed classes, far from loving it, looked on it rather as one of the necessary evils of life, but one to be endured because at least it ensured peace. Of late years, however, it had not even done that. Naturally, they disliked foreign intervention a great deal, but they dreaded still more a return of the anarchy of the previous four years. Next there were the examples before them for four years of the Shawia and Ujda Provinces. These, fiercely hostile at first, were already contented and thriving. Indeed, not a few of the troops France was employing were composed of volunteers from those Provinces. The third reason is that the instant consequence of a breakdown of Government amongst the towns of the interior and settled tribes—that is to say, the Blad Makhzen—is an inrush of some of the predatory tribes of the Blad Siba, in other words the ruin of the former.

The population of the entire French zone is officially computed at about 5,400,000, of whom about three-fourths are in the Blad Makhzen, and one-fourth are scattered through the mountain fastnesses and deserts of the Blad Siba. The predatory tribes are within only a few hours' ride of all the large interior towns. Mequinez in 1911 and Marrakesh in 1912 had had visits from them, and Fez was saved from such a visit only by the arrival of the French in 1911. The issue for the settled population was, therefore, not that of foreigner or no foreigner, but that of civilized foreigner or robber foreigner.

Here in London, and now six years afterwards, this seems simple enough, but to discern unerringly and act upon it all instantly and unwaveringly, amid the dust and suspicions and passions of those upheavals, was a very different matter. To devise and carry out successfully a policy which should be not mere slaughter and conquest, but pacification and regeneration, first of the settled populations of the Blad Makhzen, and next of the wilder populations of the Blad Siba, would be an achievement of the highest kind. Here were the factors of the problem.

Amongst the many anomalies of Morocco is that of the multiplicity of

its capitals. Fez, Mequinez, Rabat and Marrakesh all possess Imperial palaces. The Sultans' custom was to move about on campaign and to sojourn from two or three weeks to as many years in one or other of those cities. The capital was, consequently, the spot where the Sultan chanced to be. To keep the personality of the Sultan as much as possible before his subjects, this custom has been preserved as far as concerns the Sultan and the Court. A capital—or headquarters—for the administrative purposes of the new departments was, however, necessary. Opinions varied as to the merits of Fez and Rabat. Pending a definite solution of the question the Administration-in-chief has been installed at Rabat in temporary fashion. There the Resident-General lives in a comparatively small house with spacious grounds, within which he is surrounded by thatched bungalows containing the various departments. Controversy still rages on the matter. Enthusiasts of one sort call the place a Senegalese village unbefitting the dignity of France's chief representative, while others see in its resemblance to a collection of beehives the most suggestive and inspiring environment imaginable for such work and such workers.

The Moorish Government consisted of:

The Sultan, head of the State and (religiously) "Prince of the Faithful," Supreme Judge. Around him much pageantry and show of power, crowds of soldiers, of levies, of tribesmen, and household functionaries, slaves and servants.

Bashas or Kaids, over town and provinces.

Sheikhs, under them, over quarters of towns or villages.

Cadis, judges in matters of law.

There were no real Ministers of State. The so-called Viziers were simply half a dozen head scribes of the Sultan, who sat in small rooms at the Sultan's gate, or in tents near the Sultan's tent, each surrounded by half a dozen under-scribes. No class of the native Moslem population had any modern education whatever—that is to say, any such knowledge as is indispensable for carrying on any sort of modern public department. Fifteen to thirty years would be necessary to create such a class of native public servants. The point, therefore, was whether to wait all those years till this class could be trained, and meanwhile merely to supervise the Viziers' carrying on, on their accustomed lines, or to create the departments at once, staff them with Frenchmen, and let the Viziers be consultants and be the intermediaries between the departments and the Sultan. As time went on educated classes of Moors would come into existence. Both now and afterwards the Sultan and Court would lose nothing of the ceremonial and display of power which the public of Morocco loves and expects to see. Salutes by guns are not made to any member of the protectorate administration except the Sultan. A weekly Council is held by the Sultan at which the heads of departments submit for his comments and approval reports of the work in hand and in prospect, and on the public situation in general.

Here our past problems in Egypt, the Sudan, and Zanzibar naturally recur to the mind; but, as any inquirers will soon find, comparisons with them are not practical as regards details. While presenting, superficially, many features in common with Morocco, the circumstances of each of those countries vary so much from Morocco that any system which fits one of them at all well would necessarily be a misfit for any of the others. The comparison therefore could only be with an imaginary British Protectorate composed of those elements and circumstances in Egypt, the Sudan, and Zanzibar which resemble those of Morocco.

A glance at their respective circumstances will be sufficient to show how different were the difficulties of the French reformer in Morocco from those of the British reformer in Egypt. In Egypt the central government was already on a more or less modern footing. State departments existed, sound enough in theory, but inadequate and corrupt in practice. In Morocco there were simply none at all. In Egypt, therefore, influence in one department after another had to be laboriously acquired, and pre-existing interests to be overcome.

Next, the cost of the reforms had in Egypt to be paid for by the Egyptian Treasury out of Egyptian revenues, and these were subject to the International Control of the *Caisse de la Dette*. To escape that Control reforms could be provided for only out of unforeseen or ingeniously contrived savings in expenditure, and at the Control each member's vote was apt to be determined by the political *quid pro quo* to be got for it rather than by the merit of the proposed reform itself. The French reformers in Morocco could, and did, have recourse to loans from France, in the spending of which no International Control had anything to do. Further, many reforms being in the first instance necessary for the proper working of the French army of occupation could be, and were, provided for out of the Army vote of France.

Further, the interior taxation of Morocco was very little mortgaged and that little was in favour of the *Contrôle de la Dette*, practically a French institution not likely to raise insuperable difficulties. Some improvements in the French zone have, of course, been paid for out of the *Caisse spéciale* (2½ per cent. extra import duty under the Act of Algeciras), and so have to be contracted for by public adjudication, but none of those yet done of this category are of more than local importance.

Lastly, in Morocco France's position was clear. The zone was declared a Protectorate. It is only since the war began that Egypt has become formally a British Protectorate. How long the French reforms in Morocco would have taken to accomplish under the conditions of Egypt, and how quickly ours in Egypt could have been effected had the conditions been those of Morocco, who shall say?

But as to what the goal should be, there is, as will be seen presently, absolute identity of ideal in Egypt and Morocco. It should be the administering and developing of the country in the interests, first of all,

of its inhabitants. This is not benevolent sentiment only, but common sense. In Morocco, as in Egypt, the natives will always be the immense majority of the population and, as so largely the owners of land, they will also always be of the greatest economic importance.

One is tempted to use the metaphor of the setting up of a machine to the programme now adopted, but I prefer the simile of a course of medical treatment, for, properly viewed, the work was and is a huge effort to heal. One of the earliest and best-known British missionaries in Morocco, when doubtful whether her fever patients would really take the course of medicine she prescribed, often, and invariably with excellent results, solved the problem by administering the whole course, laxative, quinine, and tonic, at one dose! Here, then, was the dose now prescribed for the fevered French zone. The mere mention one by one of its ingredients will show how many and how various were the maladies of this patient.

First, the establishment of public order to pacify province by province, with as little force as might be, and such force accompanied by a service called the Native Medical Assistance, working on the plan known before and since as that of the "drop of oil," or "oil stain" method, from the quiet but sure and effective manner in which it radiates its influence. It is an invention of General Lyautey's. Its sub-ingredients include the troops trafficking and mixing with the people as much as possible, and the establishment of posts at points which should be useful for local trade as well as military control. The south-eastern and southern Atlas provinces were to be controlled indirectly by means of the great feudatory chiefs of those regions, mediæval grand seigneurs living in their castles. This has been done; and those chiefs have maintained the most steadfast loyalty throughout the war.

Since 1911 the pacification movement from the west has reached the general line of the Blad Siba on its west side; and from the east it has not only reached the east side but has joined up with the west in two areas, thus cutting the unsubmitted area into two widely separated tracts: the highest, wildest, and least habitable of the whole country.

Second came the creation of a finance service and the making of a Budget, the latter a thing unknown in the country!

Except for the customs duties at the coast and the frontier, and the various town dues, payment of taxes had practically ceased in 1912, and the former were almost wholly mortgaged to the Morocco loans bondholders. A Budget, necessarily fragmentary at first, but now fairly complete, has been established. Urban taxation has been reorganized. Rural taxation is now largely introduced, and the taxable areas are continually being extended.

Here in round figures are the results of the Budget:

RECEIPTS.

1913–14.	1914–15.	1915–16.	1916–17.	
£637,000	£871,900	£1,653,000	£2,214,000	West Morocco.
96,000	79,000	114,000	146,000	East Morocco.
£733,000	£950,000	£1,767,000	£2,360,000	Totals for French zone.

Into the various items of which these figures are composed it would take too long to go, but any one in search of information on these or any other points connected with the Protectorate Administration will find all the particulars in the *Annuaire Economique et Financier*, published officially by the Treasurer-General of the Residency-General at Rabat.

Moorish functionaries in towns and the Cadis in towns and in the country have been put on salaries. Moorish functionaries in the country get, instead of salaries, various rates of commission on the amounts of agricultural tax (the "Tertib") collected by them: an admittedly unsatisfactory system, which, however, will be altered as soon as circumstances permit.

Thirdly, it was necessary to create public works. In 1912 there were practically no ports: only open roadsteads and tiny jetties, often drenching-places rather than landing-places. They are now furnished with quays, stores, sanitary services, and the like; and the deep-sea steamer port-works of Casablanca are now three-quarters finished. Casablanca itself, from a rather squalid Moorish town of 10,000 inhabitants with 500 Europeans only, has grown in these ten years into a well-equipped European town of 82,500 inhabitants, including 37,500 Europeans. Kenitra, merely a Moorish kaid's castle and village in 1911, is now a flourishing little port with 3250 inhabitants, 1150 of them Europeans. At Fedala another new port has been established. At Rabat, Mazagan, Safi, and Mogador important improvements too numerous to detail have been effected.

Apart from the military there are now in the interior towns and country alone upwards of 10,000 Europeans, as against some 250 or so in 1911; and this notwithstanding the withdrawal of men of the Allied nations to Europe for military service. In the other towns of the coast the European population now numbers about 9000 altogether, against about as many hundreds sixty years ago.

In 1912 the line from Rabat to Casablanca was as yet only in its early stages of construction, and the others were not even in project. The light military railways made since then, and now at work, extend to no less than 511 miles. About 100 miles more are in construction, the Fez-Taza section and the Marrakesh end section, and these should be complete in twelve to eighteen months. This done, unbroken railway connection between Tunisia, Algeria, and across Morocco will be assured.

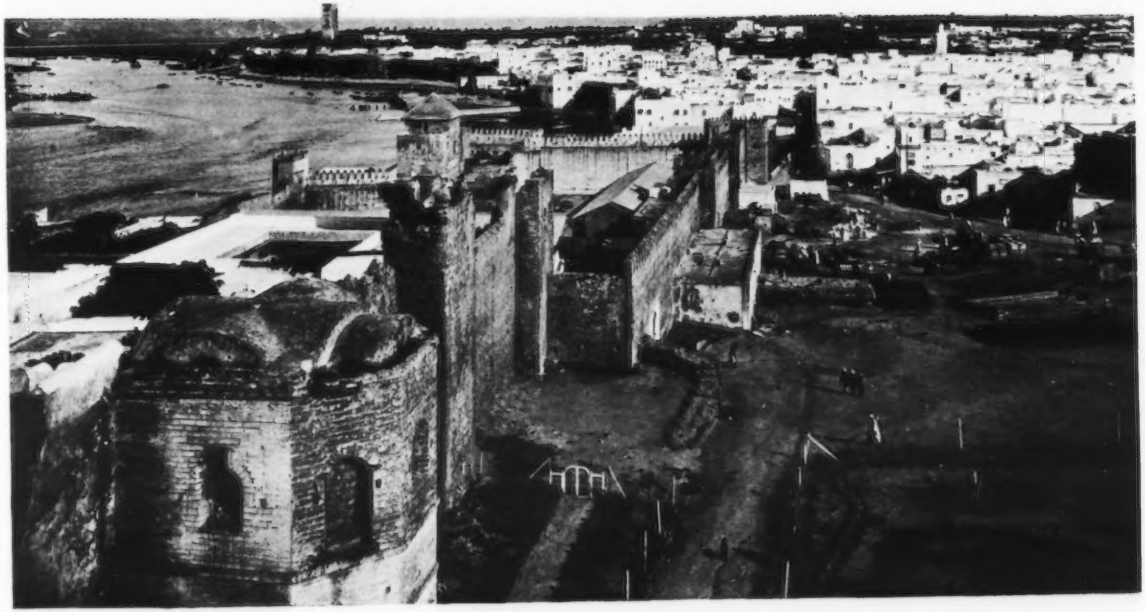
The permanent wide-gauge railways are in the "survey" stage, and will replace these 27-inch gauge lines, which will then be lifted and transferred, no doubt, to the Blad Siba, when its turn comes to be pacified. Before the war, treaty provisions precluded their use for other than strategic purposes, but they have since been opened to public traffic. How useful the light railways are proving meanwhile will be seen from the returns for May 1916 to May 1917, which show 144,298 military passengers, 101,536 civilian passengers to long-journey stations only, and 42,392 tons of civilians' goods, with civilian public traffic receipts of £161,628.

The trains taking goods and passengers cover about 50 miles a day. The motor carriages for first-class passengers and mails carry the traveller about 150 miles a day. At various stages hotels and restaurants have sprung up, all of which, when the old conditions of travel I have already described are remembered, will afford some notion of the revolution which has been accomplished in travel for passengers. For goods the change and its consequences are still greater. No foreign article weighing more than 3 cwt. (one side of a camel's load) was formerly transportable to the interior except at a cost, for animals and special apparatus, practically prohibitive. Now practically anything is transportable.

The map shows the roads made since 1912 of the first and second class, good hard "carrossable" roads, exclusive of upwards of 700 miles of caravan tracks made practicable for wheels in dry weather. Of first-class macadamized roads, 8 metres wide over all, with 4-metre causeway, there are more than 500 miles complete, and as many more in construction.

In agriculture, as in other directions, almost everything was lacking which governmental intelligence ought to have supplied. Since 1912 agricultural, horticultural, aboricultural, veterinary, and meteorological services have been established, and annual agricultural and cattle shows and rural provident societies have been instituted. All these are already proving of the greatest value in improving the methods whereon the chief wealth of the country depends. The principal crops are wheat, barley, maize, millet, linseed, flax, hemp, chick peas, beans, coriander, fenugreek, and lentils; the principal fruits, olives, argan tree, vines, almonds, oranges, and lemons. The municipal nursery gardens established at all the principal towns do excellent work in inculcating proper methods of fruit and vegetable growing. The veterinary service, besides the care of animal health, repression of epidemics, and so forth, gives active assistance in teaching better methods of stock raising.

A comprehensible statement in arithmetical terms of the developments in all those connections is not however yet practicable, because the only figures available are those of the tax-paying areas, and as yet these, though extending year by year, consist of only a tenth of the pacified part of the French zone.



RABAT: THE NATIVE TOWN

CROSSING THE BAR, PORT OF RABAT

RABAT: WALL AND GATE OF CHELLA

The rough totals of exports and imports are :

1911	£5,880,000
1912	£7,109,430
1913	£8,864,300
1914	£6,960,000 (Outbreak of war)
1915	£9,437,600
1916	£12,434,160

Rise of prices, of course, accounts for much of the increase, but the figures (too long to go into) show that the trade increased in quantity as well as in value. The progress of British trade can best be shown by the imports only, exports (owing to the war) having gone almost wholly to France. From £831,600 in 1911 it rose to £2,272,000 in 1916; and here again rise of values does not account for all the increase.

Notwithstanding the war, a large exhibition of Moorish and French arts, goods, and products was held at Casablanca in 1915. In 1916 the first of a system of huge fairs, to be held annually, took place at Fez, and the second at Rabat last autumn. Of very particular value are the *bureaux économiques*, with commercial exhibitions attached, which have been established in all the principal towns.

Postal services maintained by various powers had existed for many years, but, except the British postal service, have since disappeared. To-day of course the mails go by rail or motor, in as few hours as they would formerly have taken days to reach their destination by foot runners. The number of post offices has increased from 56 in 1913 to 138 in 1917, and such offices now exist at all the towns and administrative stations of any importance from one end of the French zone to the other, and have money-order, telegraph and telephone in addition to postal facilities. To smaller or more remote military stations mails go by the military service. Telegraph and postal facilities are afforded to the public at such stations.

In four years, 1912–1916, the traffic had multiplied itself by six; and this does not include soldiers' mails by the military postal services. Similar results could be shown in the money order services.

There were no telegraphs in the interior in 1911. To-day there are 2338 miles of lines, with 6102 miles of wires. In 1911, with the French army of occupation the wireless telegraph arrived in the interior, an innovation more impressive than any before or since experienced by the foreigners living there, so much did it remove their feeling of isolation from the rest of the world. The difference which it has made to their security is impossible to measure.

The superiority that hostile tribes had always enjoyed in communications disappeared with the advent of the wireless system. To Fez by wireless, picked up from a Poldhu message to mid-Atlantic liners, came

the news of the Agadir incident in 1911, and since the war Fez gets its daily communiqués from the Eiffel Tower.

The most valuable forests which remain—the cedars of the Atlas—are as yet mostly inaccessible. But from the frontier posts south of Mequinez some forests are already being worked. The motor lorries which revictual such posts often come back loaded with cedar logs. This you will understand is from an area, part of the Blad Siba, formerly absolutely lawless. The remaining cork forests of the coastal regions have been taken under control, and yielded a revenue in 1916–1917 of £16,700. In the mean time, however, this element is of future rather than present interest, for the first efforts have been necessarily towards preservation rather than exploitation.

Irrigation is as yet only in the inquiry stage. The waterfalls of the western slopes of the Atlas are in particular expected to prove of great value as sources of power.

In October 1912 there were in existence 9 French schools, primary only, for Europeans; 14 Franco-Arab schools for Moors; and 14 Franco-Jewish schools, having in all 3000 scholars under 61 teachers. On 30 June 1917 there were 83 French schools, including some secondary schools; 62 Franco-Arab schools, including a Franco-Arab college at Fez; and 35 Franco-Jewish schools, with over 20,000 pupils, of whom 1600 were in higher and secondary schools, and 600 in technical schools. There were even schools for the children of the Senegalese soldiers. Schools for fisheries and navigation are in preparation.

There are also Arabic evening classes in the winter months for Europeans, free to all comers, and, almost since the beginning of the present régime, a college at Rabat for the study of Shilha, attended chiefly by military officers and civilian functionaries, but open to all. How very important a subject this is will be seen from a language map. Over the greater part of Morocco, Shilha in its various dialects, and not Arabic, is the language spoken. It is known by hardly any Europeans as yet, and acquaintance with it cannot fail to be of great importance as the northern, central, and southern areas of the country open up. I trust it, as well as Moorish-Arabic, may by-and-by find a place amongst the languages taught at our School of Oriental Studies in London. Moorish-Arabic had long been taught at the Berlin School of Eastern Languages, and the Germans had compiled a grammar of Shilha. So far as I know, the only English-speaking persons who have any knowledge of Shilha are, with the exception of Sir Donald MacAlister, Principal of Glasgow University, the American missionaries at Mequinez and Sefru and some of the British missionaries at Marrakesh. Shilha has no written characters or literature of its own. To acquire any general education, Shilha-speaking people must learn some foreign language and, for its greater

value when once acquired, French rather than Arabic will probably be the medium employed.

I have referred on another occasion to the medical work done, these nearly thirty years, by the British missionaries in Morocco, especially in the interior, as at Fez where they attended 17,000 cases a year, and at Marrakesh 45,000. There were besides some few European doctors and dispensaries in the coast towns. For the rest—in 1912—the whole population of the interior (say five millions) of the French zone was without doctors and without medicine. Figure to yourselves what their conditions were when every disease, endemic and epidemic, had its way practically unchecked, and mostly aggravated by all that dirt and ignorance can add. That was the state of the French zone in 1912. On medical work the Administration has spent about £200,000 in these six years, in supplement of what is paid out of local funds; has established 68 hospitals, dispensaries, special institutes, and lazarettes for isolating infectious diseases. All this besides the itinerant native medical assistance service with the military columns in the far interior. In 1916 no less than 900,000 attendances at these various establishments were registered, which is equivalent to saying that about one in every five of the whole population had had medical care in the course of the year. Indeed, one in four would be the better estimate, for of course about 1,000,000 persons in the Blad Siba are as yet beyond reach of the medical services.

All this, I suggest, constitutes an achievement hard indeed to grasp either as regards the immensity of suffering it has relieved, or the vast influence it must exercise on the peoples it has touched, or the impulse added to their energies by the diminution of such diseases, or the saving of life, especially infant life, and the increase—the doubling or trebling—of population which must be its fruits a generation hence. To the European resident in the interior has come an inestimable boon in the form of the hospital facilities afforded by the military hospitals to Europeans of all classes, who are received and treated on the footing of private soldiers, non-commissioned officers, or officer, according to their station.

Within eighteen months, *i.e.* in September 1913, Franco-Moorish law courts (Court of Appeal, Courts of Assize, and Petty Courts, Civil and Criminal), and a special code of laws, were established for the judicial needs of Europeans, and for cases wherein Europeans were interested. The Code alone consists of some 250 quarto pages of small print. I cannot illustrate this, but the industry and energy here are surely too obvious to need illustration.

Unless in cases requiring capital punishment the native, under the old régime, when accused of any offence, was tried by the Governor, who might discharge him or cast him into prison with or without thrashing him. There was no control or right of appeal, and no scale of punishments.

The accused simply remained in prison until he or his friends could buy his release from the Governor.

As now reformed the Governors can, without control, inflict sentences up to fourteen days' imprisonment only. Sentences above fourteen days and under one year are subject to confirmation by the local French controlling officer. More serious cases are referred to the Sultan, who decides them on the advice of a committee of Moorish jurists, this committee in turn being under French supervision. Of all cases the Governors have to keep registers; and the registers, even as regards the pettiest class of cases, are inspected, and if necessary suitably commented upon by the French controlling officer. The mere mention of such judicial changes may afford some notion of the oppression and injustice previously obtaining, which were almost inevitable under so tyrannical a régime.

The activities of the Antiquities, Historical and Fine Arts services cover a wide field. They include the discovery and preservation of all buildings, or remains, or monuments, or places of historical, artistic, archæological or scientific interest, town planning, the supervision of the æsthetic side of the revival of native industries, and the control of plans for public (and even for private) buildings if the amenity of the neighbourhood be affected. The discoveries and preservations made at Fez of Moorish fourteenth-century architecture should alone be sufficient to make Fez a rival in future to Granada as a resort for students of Saracenic arts and architecture.

When the French occupation began a Professor of Arabic at Cambridge wrote to the press prophesying the immediate decay of the Arabic language in Morocco. Sir Harry Johnston replied that in his opinion the Arabic language there was about to take a new lease of life. And he has been right. More Arabic and of a better quality is taught, spoken, written, and printed than ever before. If the professor has doubts let him visit the Moslem College at Fez, or the Interpretariat department of the Government, or hear the Moors' speeches at public functions.

The thoroughness of the Arts service as regards Arabic may be imagined when I mention that it supplies (and compels the use of) models for the Arabic writing of signboards for streets and railway stations in order to ensure that the letters be used only in their original and beautiful forms instead of the ugly and corrupt shapes they had begun to take.

The domains and mosque properties present problems the most complex, obscure, and embittering to deal with of all the reforms which have been set on foot. The former are under a Government department; the latter under a native commission with a French control supervising it. The work is largely that of recovering the long-lost or partly lost private domains of the state, and the patrimony of the mosque and charitable

THE CITY OF FEZ, FROM THE CEMETERY OF BAB FETUH

IN THE AGUEDAL, MARRAKESH

FEZ: BAB FETUH

foundations. So far the work accomplished has at least stopped further leakages in both of these connections, but much yet remains to be done before the whole of the domains and mosques' possessions, rights, servitudes, and the like are made clear.

The administration publishes, in Arabic as well as in French, a weekly official newspaper, the *Bulletin Officiel*, which contains not only the official texts of decrees and legal notices, but full reports of all that is being done by the various departments, official studies, and reports on subjects of interest. It has become a mine of information in regard to Morocco.

That I do not give figures about the valuable part the French zone has played in the war, whether as to soldiers or labourers or supplies, is only out of regard to the censor. How the Moorish soldier has behaved, now that he is properly instructed and armed, properly fed and clad, honestly and regularly paid, medically treated when sick or wounded, decently buried when dead, rewarded and honoured when deserving distinction, will be understood when I mention that, on the front in France, no fewer than three hundred out of five hundred ex-Fez mutineers have gained medals or promotions for courage or good conduct.

Lastly, I may mention the Topographical Service, whose minute and beautifully executed maps continue to be published as further and more exact data become available.

Many more successes could be cited, ranging from a brilliant little campaign last year in the farthest south-west—the feudatory kaids and the French against Hiba and the Germans—to drastic anti-alcohol legislation and the introduction of game laws. However, in the time available I trust I have told enough to enable you to form conclusions both as to the amazing transformation which has been accomplished, and as to the future thereby opened for this part of Morocco. Larger than England and Scotland, it has only an eighth of their population. It has long been only 40 to 70 hours' sail from French ports and 60 to 90 hours from British ports.

It is rid at last of the cancerous administration which isolated it from civilization and progress for four hundred years; almost rid, too, of its other cancer, the Blad Siba, and we now see it healing rapidly, and, under that far different administration I have endeavoured to describe, starting on a new era of its life. Such an era cannot but prove the most happy and prosperous in her history; and its advent, within six years of its inception, sums up, I think, the Achievements of France in Morocco.

Before the paper the PRESIDENT said: Mr. MacLeod, who is to address us to-night, has been long resident in Morocco, and there is little with regard to that country that he does not know. He enjoyed opportunities as our Consul there of acquiring information from every possible source. We are, I think,

certain to hear from him a great deal that is new as well as much that is of general interest.

(*Mr. MacLeod then read the paper printed above, and a discussion followed.*)

The PRESIDENT: We have heard a marvellous account of the achievements of the French in Morocco, and have fortunately two or three gentlemen here who are well able to substantiate the statements that have been made to us on the subject. Captain Boillot is here representing the French Embassy. I introduce him to you as an officer who has done distinguished service at Verdun and in the battles of the Somme.

Captain BOILLOT: The unexpected honour of representing His Excellency the French Ambassador was thrust upon me at the eleventh hour—I suppose in these Daylight Saving Bill days I ought to say at the tenth. In any case, I must apologize to the President of this Society and to honourable members now listening to me for the very inadequate way in which I can thank Mr. MacLeod for his interesting and remarkably comprehensive lecture. Fortunately, my method of dealing with the subject does not, as you will readily understand, detract anything from the sincerity of our feelings of gratitude. The convulsion which is now shaking the greater part of France is so tremendous that to some extent it overshadows the efforts of my compatriots in other parts of the globe, and at a time such as this it is most gratifying and encouraging to realize that those efforts have been witnessed and appreciated by our noble allies. It is no small honour for us to receive praise from those of the British nation on the subject of colonization, and the consciousness of all that we have to teach other nations does not blind us to all that we have to learn from them. We know that in the matter of colonization the British Empire is a standing example to every nation of the Earth—I mean such nations as will, after the war, have an opportunity of colonizing, and I sincerely trust and hope that this privilege will be denied to some of them. Therefore, on behalf of His Excellency the French Ambassador, I have much pleasure in thanking Mr. MacLeod for his most enlightening and inspiring account of the achievements of France in Morocco.

Mr. R. B. CUNNINGHAME GRAHAM: We have had a most interesting and exhaustive lecture from my friend Mr. MacLeod. During the last thirty years I have frequently visited Fez—I cannot remember how many times, though probably Mr. MacLeod can, as I have no doubt that I was a dreadful bore to him when I came. All that he has said to you who do not know Morocco has been instructive, interesting, and, I have no doubt, will give food for reflection. But to one who knew the country thirty years ago it has been a fairy tale. I have followed the lecture and have watched the country develop and civilize and become greater and more analogous to a European state year after year as our lecturer has spoken. When I first visited Fez it took eight or ten days to travel from Tangier, if the roads were good. You went along stumbling like Christian on the path to heaven; in heat, in cold, in dust, and in all sorts of the ordinary troubles of travel. At last you emerged upon a little plain, and in a gully of the hills, like a white cloud, Fez burst upon you. Its crenelated walls hemmed it in; it was approached through horseshoe arches over which were generally the heads of the rebels. Up in the pure sky the myriad towers of the mosques shot like flames; the palm trees waved; there was no noise, no dust, no smoke—a city of the Arabian Nights: beautiful: a dream: unlike any other city of the whole world, with the possible exception of some of those of Central Asia. You entered the town. Then the spirit of your dream was

altered. There was the press of hurrying and running; camels, mules, crowds of men in every direction. The narrow streets were like sewers, into which all the filth of all the houses was thrown, and unburied horses and mules lay at the corners of the outskirts of the town. Life was of no value. If I remember rightly, Mr. MacLeod and I once went out to see a tribal fight only a few miles from the walls of Fez. Those were the ordinary incidents of Moorish life. Many of the districts of the town were inaccessible to foreigners; they were barred off: sacred: the contaminating foot of the Christian was not allowed to enter them.

By a little anecdote I may bring before you better than in any other way the mental attitude of some of the people. Talking one day just outside the town to a reaper who had returned from the harvest in Algiers, I said to him: "Which do you like best"—he was from that very country, the Baru 'Mgild, in which the lecturer showed you that beautiful photograph of the snow upon the pines—"your own country or Algiers?" "Oh," he said, "Algiers; that is the country. The Government does everything for the people. I was there at the *fête* of the Republic. The first day we had the races. The second day I went to the theatre; one hundred Christian girls danced, each one of them worth a thousand dollars. It was Paradise! But the third day was the best, for early in the morning they brought out a French soldier, and they cut off his head with a machine." Of course it was some poor devil who had been guillotined. But such was the attitude of mind of that man towards human life he thought that was a mode of entertainment provided for the citizens by a paternal Government!

Mr. MacLeod has shown you well the material progress of Morocco during the last twenty-five years. What he has not told you of and what he has not touched upon is his own share in the evolution of civilization there. I knew him thirty years ago when he was one of eight or ten Europeans; when life was dangerous and uncertain for the European who ventured 5 or 6 miles outside the town; when, if one did not exactly have to crawl into the presence of the Sultan, one had to go there with some precautions. I have been there with him. All that is changed. I need not speak to you of the difficulties he encountered, the prejudices he had to throw on one side; of the intrigues of nations now friendly to us; and of all the difficulties that an ill-paid and ill-supported Consul in a lost corner of the world, such as Fez, has to undergo in order to make the name of Britain respected, as he did there in that city. He raised it; he forced the Moors to consider Great Britain, to salute our flag. What he did for British prestige in that town few but myself really know; and I am glad to be here to testify to the immense work that our lecturer himself did by the example of his life, by his thorough knowledge of the customs of the country, and by his indomitable and invincible patience, in dealing with the oriental mind and oriental diplomacy, to make the name of Great Britain respected in a country where nothing was respected except force and cruelty. He has told you of the evolution of the country; he has touched briefly upon the increased longevity owing to better sanitation and to medical advice. I myself remember when I was about forty-five years of age gazelle-hunting with some of the horsemen of the Beni-Duarein—a tribe outside Fez. A man asked me how old I was, and was astonished that a man of forty-five could still ride and gallop and endure a long day in the hot weather. Those hardy tribesmen rarely reached the age of fifty. The infant mortality was something terrific throughout the country; men and women of between forty and fifty seemed aged and worn-out people. The effect will be, as the lecturer

has said, to treble or quadruple the population, certainly, in the next generation. And what will be the result? What has been the result of all these reforms on which the lecturer has so well touched? Morocco to-day is no more an African, but a European country: with the same economic laws, the same method of life almost (with the differences of religion) to be observed there as are to be observed in southern Europe, and in fact the country has entered into the great family and polity of European nations. What is to be deduced from that? That it is impossible for any one nation to monopolize the trade or the influence of a country which is practically one of the European countries. Of course I am speaking to British subjects, not to Germans. My proposition would have but little weight with them, I understand. But to ourselves, to the French, and to any other civilized nation it must be manifest that a country which has entered into the fellowship of the rest of the European countries cannot be made a *mare clausum* and kept reserved for the commerce of any one particular nation. At that Peace Congress which perhaps some day will come, one of the questions to be discussed will most likely be the following: a proposition undoubtedly will be made—has been made, I understand—that we should entirely clear out of Morocco if the French will entirely clear out of Egypt. Now an *entente cordiale* is a splendid thing in war time, but in peace it will not fight. There is no peace betwixt commercial jealousies and rivalries. It has been the practice of France in dealing with her colonies to exclude by tariff walls and other means all foreign commerce. I do not see why the British merchants who have passed their lives in Morocco, who have devoted their capital, their industry, and their energy to develop British trade there, should be made the mere sport of any Government in regard to their position. The Foreign Office naturally has no policy; it would not be a Foreign Office if it had. It rests with us to indicate a policy for that Foreign Office, and that policy should be to keep—without quarrelling with the French, of course—British interests in Morocco, to extend our trade there, to endeavour to cater for the commercial wants of the country, and by no means to listen to the counsels of those who would wish us to leave Morocco if the French would leave Egypt, because should we do so we should lose most heavily, not only in prestige but in our commercial affairs. It is not for me to say more when there are so many, I have no doubt as well or better qualified than I am, to address you upon Morocco; but if you will allow me, before I sit down, I will once more tender for myself, and I hope for those gathered together before me, thanks for the most interesting lecture; and once more, most emphatically, I wish to impress upon all who hear me the magnitude, the self-abnegation, and the sincerity of the work that our lecturer has undertaken in Morocco during the last thirty years.

Sir ARTHUR HERBERT: It is indeed a surprise that I should be called upon at this late hour to speak upon Morocco, a country which I only knew very cursorily twenty-five years ago. I was there with Sir Ernest Satow, who was Minister, for a short while, and I look upon the time I had with him as being the most instructive and possibly one of the most pleasant in my life. He was an all-round man, who could speak on any subject, an oriental and a European scholar. When we were in Tangier we had an enormous number of cases, and I think Mr. MacLeod will bear me out when I say that Sir Ernest Satow learnt Arabic sufficiently to understand and to go into the merits of nearly every case. And if he did not understand he took expert advice. He went up to Fez and stayed there, and he came down with a clean sheet, which

was a most remarkable performance. Sir Ernest Satow was not a man to advertise himself, but I am glad to have this opportunity of testifying to the enormous work he has done. As for Mr. MacLeod, I can only say that it was a great pleasure to me to see him here after twenty-five years. I know the work he did in Fez; I was a recipient of his hospitality; and the few days I spent there were most pleasant. I have heard of him from time to time ever since, and have witnessed the very great work he has done, and the self-abnegation he has shown in remaining in Morocco and carrying out the work of caring for British interests for thirty years.

The PRESIDENT: I have regretted all my life that I have never been anywhere near Morocco. There is a point which I think many of you will recognize at once as indicative of the extraordinary progress which the French have made there. Not so very long ago a lecturer here told us of his journey south-east from Mogador to the Atlas range, where he found a very beautiful valley at the foot of the Atlas Mountains, and was entertained royally by a local sheikh and his village people. But after he left he found that a very ingenious plot had been made to murder him, and he heard that the sheikh who had entertained him and all the villagers who had assisted were massacred by the people from the hills. It was eventually proved, beyond the shadow of a doubt, that all this was due to German intrigue and German money. That was in the year 1911—just those six or seven years ago when the French began their reclamation of Morocco. One would like to ask what has become of German interests in Morocco. It seems to me that we may possibly be able to congratulate ourselves that the occupation of the French there, their marvellous energy, their remarkable achievements, have completely superseded them. I rather regret that in the course of the lecture Mr. MacLeod has not been able to indulge in a few more personalities. Many of us would like to know something about that very picturesque old rascal Rasuli, the most powerful Arab in Morocco, who will, no doubt, in a comparatively short time, figure in war-time history. You will all agree that we have enjoyed a most interesting paper, and I will ask you to join in a formal vote of thanks to Mr. MacLeod for his address.

RESECTION IN SURVEY

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Read at the Afternoon Meeting of the Society, 15 April 1918.

RESECTION in survey is a method of observation which is opposed to Intersection. An outpoint, itself unoccupied by an observer, which is observed *from* fixed stations, is known as an "Intersected Point." An outpoint which is occupied and whose position is determined by angular measures made *to* fixed stations which are not themselves occupied for the purpose of determining the position of such a point, is known as a "Resected point." If A is a fixed station and P an outpoint, non-reciprocal observation from A to P implies intersection; from P to A, resection.

This method of interpolating positions possesses considerable advantages from the point of view of speed, economy, and convenience. In

certain kinds of work its advantages are so overwhelming that practically no other course is open to the surveyor; it is in consequence most commonly employed by topographers, including hydrographers. It is safe to say that a great, if not the greater, part of our knowledge of the superficial features of the Earth is due to the almost universal employment of this method for the construction of maps and charts. When a country has reached that high degree of development which is characteristic of our home lands, that is to say, when the country is covered by an accurate cadastral survey with which topography is united, the employment of the method is no longer necessary; but it is far otherwise in undeveloped or less highly developed countries. Here the mere question of economy renders its employment necessary. Here the enormous saving of time rendered possible by a method of fixing one's position by observations made *in situ* is usually the consideration which alone enables the State unsupported to carry out in the early stages of its development a general delineation of its superficial features.

To understand the reason for this great saving in expense it is necessary to remember that main stations are usually situated on the highest positions, and, in consequence, most frequently in areas not easily accessible; and even secondary stations are not always easy of access. But much more important than this consideration is the fact that these stations are necessarily limited in number, and from them it would be impossible to map all the detail in the district. Topography obviously involves an immense amount of detailed work, and the smaller features can be taken in only if the number of topographical working sites is greatly multiplied; more especially is this the case in countries greatly broken.

To carry out such a survey it is necessary in all cases to have a minor triangulation, consisting of secondary points. These triangles may again be broken up so as to give a sufficient number of tertiary stations to form the fundamental positions for the topographer. The tertiary stations may sometimes be fixed by trigonometrical interpolation; that is to say, by employing the method of resection in conjunction with a theodolite. In very difficult circumstances, such as in the region of the Himalayas, Hindu Kush, and Pamir, trigonometrical interpolation may be perhaps the only possible means of fixing the position of the higher peaks. In general, however, with the fundamental positions of his survey all fixed by theodolite with considerable accuracy, the topographer finds that the plane-table or camera gives sufficiently accurate location of detail, with enormous saving of expense.

In speaking of the accuracy of the method, one must distinguish between the accuracy inherent in the method and the accuracy of the method in conjunction with a given instrument. There is, for example, a profound difference between the results obtained by a plane-table and, say, a good 6-inch theodolite. While it is to be remembered that where one

instrument is useful the other is useless, and *vice versâ*, this paper regards the subject more from the point of view of the worker with the theodolite; where the occasion suggests it, reference will be made to the plane-table, in connection with which the method has received already the full treatment which the almost universal employment of this *Mensula prætoriana* demands. Further, since high accuracy is not required from the plane-table, any discussion would be foreign to those parts of the present paper which are concerned with the computation of error. On the other hand, in so far as the present investigation indicates positions which may be obtained geometrically, it applies as much to the plane-table as to the theodolite.

The inherent accuracy of the method is not so great as that of intersection. Roughly speaking, the displacement of a resected point remote from the danger circle varies as the square of the distances from the fixed stations, while the displacement of an intersected point consequent on errors in the angles varies as the distances. Nevertheless, the author is of opinion that the limitation of resection is more a handicap of position than a consequence of inherent and unavoidable inaccuracy. It ought to be remembered in comparing the two methods that, in the case of two measured angles, intersection implies observations from two fixed stations only, while resection demands three, thus securing some compensation towards increased accuracy. If the resected part is well placed, there need not be any great difference between the errors in the two methods. This is proved by the following considerations. Suppose that a point P is fixed by resection from three stations A, B, C, and again by intersection from A and B. Suppose also that the sides BC, CA, are a, b respectively, PA $= p$, PB $= q$, PC $= r$, and that the angle APB at P is γ, while that of the fixed triangle at C is C. Then if the mean square error of an angle be μ_a'', the mean square error of the position of P is

By resection . $\pm \mu_a r \operatorname{cosec} (\gamma - C) \sin 1'' \sqrt{(q^2/a^2 + p^2/b^2)}$,
By intersection . $\pm \mu_a \operatorname{cosec} \gamma \sin 1'' \sqrt{(p^2 + q^2)}$.

The similarity between these two formulæ is striking evidence of the justness of the contention here put forward. If q is comparable in length with a and p with b, and $\gamma - C$ is not near 0° or 180°, the two results need not greatly differ. It must be remembered, too, that there is a limitation of position in the case of intersected points also; the triangles must not be too badly conditioned. We see this very clearly from the formulæ, each of which includes an element of weakness; without involving errors theoretically infinite, γ can be no more equal to 0° or 180° in intersection than $\gamma - C$ can have the same values in resection. It is quite possible to have an excellent position for resection from three stations where intersection from two of them would be useless. In summing up, then, it may be said that, while intersection is in general the better method, there is a limited field within which resection will

afford quite comparable results—a fact not generally known. If we are to consider intersection from three, we ought equally to consider resection from four fixed stations, the number of measured angles being the same in both cases. To determine means of estimating *a priori* the precision of resection, and alternately the possibility of utilizing the method in given circumstances, is one of the chief objects of this paper.

Owing to the limitation mentioned resection is never employed in purely primary survey. If used by geodetic surveyors, as may rarely occur, it is applied to the location of secondary points, and even then the observations are multiplied and reduced by the method of least squares, thus arriving at an accuracy, as proved by the computed errors, comparable with that of intersection. In cadastral survey the method is not permissible, simply because it is not necessary. This should be an absolute rule for governing internal surveys; but there may be something to be said for employing the method, under strictly defined regulations, for the location, on provisional maps, of boundary points of estates in undeveloped countries. In various places the connection of these with main or secondary stations would entail heavy expense, which should not be demanded of a single occupier, the State as a whole being responsible for these connections. But in this case it appears to be clearly a mistake to make such location dependent on plotment alone; as computation is by no means operose, it would seem that it should be required, in conjunction with sufficiently precise instrumentation. Such computation, moreover, will often provide a valuable control on the accuracy of the internal survey.

With these preliminary remarks regarding resection—a word used by surveyors and surgeons in two widely different senses, though the root idea of "cutting back" is common to both—we shall proceed to consider the various problems which are likely to arise. Of these we have already referred to the error in case of the first and most common problem; there are, however, about half a dozen in all which are of value. They may be divided into single-point and double-point problems, since multiple-point problems are very unlikely to arise unless in combination with intersection. They may also be divided into problems which are directly applicable to the plane-table and those which cannot be employed therewith without involving rather complex figures which necessitate readjustment. The plane-table is not, however, limited to the single-point problems: there are double-point problems for which it is eminently suitable. In general, however, double-point problems are of greater value for trigonometrical interpolation. They may again be divided into classes according as they involve two, three or four fixed stations, thus becoming problems of the triangle (three fixed stations) or quadrilateral (two or four fixed stations). Lastly, they may be classed according as they involve pure resection, resection mixed with intersection, or resection allied with measurement of vertical angles. These divisions are of course overlapping.

The First Problem.

The first and most common problem is illustrated in Fig. 1. A, B, C are three fixed points—possibly main or secondary stations on hills or mountains—and P is a point—possibly in a plain—whose position it is desired to fix without visiting A, B, or C. It is in general sufficient to measure two of the angles at P, marked α, β, γ. Before proceeding to an analysis of this problem, it will not be out of place to make a few remarks as to its history, which is apparently unknown in this country.

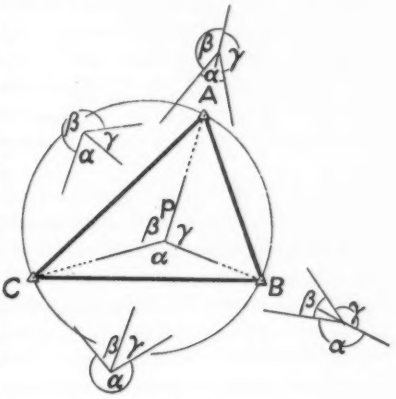

FIG. 1.

It is to Holland that we are indebted for the most complete historical investigation, in which the names of Dr. J. D. van der Plaats and the well-known geodesist Prof. J. A. C. Oudemans are conspicuous. According to Dr. van der Plaats the problem was probably well known to the successors of Eucleides in the great Alexandrian School, being an almost obvious corollary of Euclid III. 21. Indeed one might add that it would be no more absurd to think that the famous proposition followed from an attempt on the part of some old surveyor in Mesopotamia or Egypt to solve this or some cognate problem than to think that Eucleides himself was the originator of all the propositions which are so rightly identified with his name. The same authority shows that the problem was used for an astronomical purpose by Hipparchus (*circa* 150 B.C.), while Oudemans finds an astronomical application in Ptolemy also (*circa* 140 A.D.).

Nothing further is known for fifteen centuries until its rediscovery by the famous Willebrord Snel van Roien (1580–1626), who was the first, so far as is known, to employ the method for a geodetic object, some time before 1617. In this year the Batavian Eratosthenes, thus self-styled with pardonable pride, published his epoch-making work, marking the dawn of modern survey. A few remarks regarding the solution by Snellius—he is generally known by the Latinized form of the name—will not be out of place.

By Fig. 2 which follows we can indicate his proof. Wishing to fix the position of his house at Leyden, at P say, he measures the angles α, β subtended by three points A, B, C, fixed by his triangulation. In solving, he makes use of the triangle O_1CO_2, connecting the centres of the usual

circles with that apex which they intersect in common. The angle O_1CO_2 is equal to $C + \alpha + \beta - 180°$, C being the angle of the triangle, and is therefore known. Now, the radii CO_1, CO_2 of the circles are known, being equal to $\frac{1}{2}a$ cosec α, $\frac{1}{2}b$ cosec β respectively, a, b being the sides BC, CA of the fixed triangle. Hence in the triangle O_1CO_2 we have two sides and the included angle, from which the base angles CO_1O_2, CO_2O_1 can be computed. Then evidently $CP = 2CO_1 \sin CO_1O_2 = 2CO_2 \sin CO_2O_1$. Since the angle $CO_1O_2 = CEP = CBP$, and the angle $CO_2O_1 = CAP$, the other two distances AP, BP follow by the rule of sines, applied in the triangles BCP, CAP.

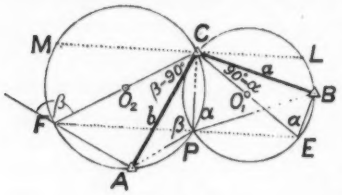

FIG. 2.

It is no excessive tribute to the contributions made by Snel to the knowledge of our Earth to follow the Dutch of Holland and South Africa and name P the Snellius point.

In 1624, Schickhart, who conducted the second European triangulation in the Swabian Jura (Rauhe Alps, near Tübingen) from 1624–35, in a letter to Kepler mentions the problem and the ordinary solution by the aid of the two circles. His measures were published in a little work entitled 'Pinax Observationum Chorographicarum.'

After Snellius, the next contribution to the problem came from one of our forgotten philosophers. At the beginning of 1671 Richard Townley, becoming interested in the subject, propounded it as a "chorographical problem." The word *chorographical* is now replaced by *topographical*, with little apparent advantage except euphony, the former having a broader and, one would imagine, a more correct signification in survey. Townley's proposition was solved by John Collins, an Oxford bookseller, whose solution appears in the *Philosophical Transactions* for 1671. Collins made a real contribution to the subject, for his solution is geometrically the neatest possible, since it necessitates the use of one circle only and an auxiliary point. We shall describe it later. Where Collins' method is employed in English text-books, I have found no reference to his name.

The next name which appears in connection with the problem is that of Laurence Pothenot. Since it would appear that he made no new contribution to the subject, and was in any case anticipated by Snellius and Collins, not to mention the ancient philosophers, it is obvious that the almost universal identification of his name with the problem on the Continent has sprung merely from ignorance of its history. Now that it has been proved for thirty years that he has no valid title, we find his name beginning to appear in English text-books, otherwise excellent.

The trigonometrical solution by aid of an auxiliary angle, now usually employed, was published by Burckhardt in 1801. The cotangent formula

is of doubtful origin; as all these trigonometrical solutions are fundamentally the same, one form quickly suggests another.

The very practical method of solving the problem by means of an approximate value of one of the unknown angles was first published in the 'Auxiliary Tables of the Survey of India.' In addition to the ordinary observations by theodolite, it demands merely a magnetic bearing of one of the lines, taken by trough or other compass. With this addition the solution is the most rapid possible.

The only instrument in special use in connection with resection is the station-pointer, an English invention apparently. By its means points can be plotted with fair accuracy. In this country its use is practically confined to hydrographers, since observations made on board ship, where a plane-table would be useless, can thus be quickly charted; in fact, at sea the station-pointer fulfils much the same function as the plane-table on land.

We shall now proceed with the first problem. In Fig. 1 the point resected is shown in several positions. If we consider one of the measured angles, say γ, then the Snellius point is without the circumscribed circle of the triangle when γ is less than C or greater than $180^\circ + C$. When $\gamma = C$ or $180^\circ + C$, the point lies somewhere on the circumscribing circle, and, as is well known, its position cannot then be fixed. We shall therefore speak of the circumscribing as the "Danger circle," because, even though the point may not be exactly on the circle, its general proximity to the circle renders the location unsatisfactory. If however the point lies near the danger circle, but at the same time near one of the fixed stations, the location *may* be fairly good. Again when γ is 180°, the point lies on the base AB. If γ lies between C and $180^\circ + C$, the point is within the danger circle; it is moreover within the triangle if γ lies between C and 180°, provided that one of the other angles, say β, lies between B and 180°. This analysis then suggests that if γ is round about $90^\circ \pm C$, the Snellius point will be well removed from the danger circle, except in the neighbourhood of the fixed stations A, B. This leads us to Fig. 3.

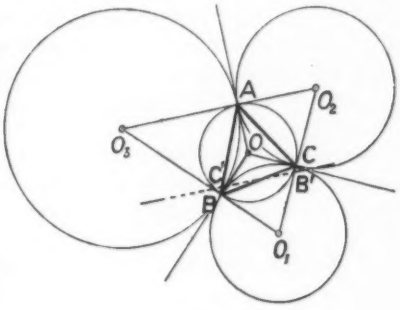

FIG. 3.

In Fig. 3 three circles are seen described on the sides BC, CA, AB, which we shall always describe as a, b, c respectively. These circles have respectively the chordal angles $90^\circ \pm A$, $90^\circ \pm B$, $90^\circ \pm C$; that is to say, the angle subtended by BC at any point of its circle (whose centre is O_1)

as either $90° + A$ or $90° - A$. Now it is easily shown that these three circles touch one another at the apices A, B, C of the fixed triangle, and that they all cut the danger circle orthogonally. We may say then, with a permissible stretch of imagination, that a point moving on any of them endeavours to keep as far away from the danger zone as possible. Still it must cross the danger zone twice on each circle; but, since these crossings are at fixed stations, where no danger can arise within the absolute limits of the station,—a somewhat theoretical conception, and since, in any case,—as is much more important,—no one would employ resection within the purlieus of the fixed stations, these latter may be correctly designated "Neutral points." We shall subsequently see that there may be neutral points in a figure in addition to the fixed stations.

We shall therefore name the three circles O_1, O_2, O_3 the "Clear" or "Safe circles." Within the three-rayed star between them, if we clip off the cusps of the rays, resection will be absolutely safe. Outside the danger circle the clear circles give some indication of the limits beyond which the Snellius point should not be placed; but this rule must be used with reservation, for if the angle C, for example, were 90°, the circle O_3 would become the line AB, and obviously one could not work along AB indefinitely.

There is a simple construction for the centres of the clear circles. On AB mark off $AC' = AC$, and on AC, $AB' = AB$. Then the line O_2O_3 is parallel to $B'C'$. Similarly for the other lines of centres.

In Fig. 2 there is shown a common geometrical method of determining the Snellius point. The two angles observed being α, β, draw CE, making the angle $BCE = 90° - \alpha$ with a, and CF making the angle $90° - \beta$ with b. If either (or both) of the two values $90° - \alpha$, $90° - \beta$ is negative, the corresponding line (or lines) must then be drawn outside the fixed lines. At B and A erect perpendiculars BE, AF to a, b respectively. Then with the middle points of CE, CF as centres describe circles; these cut in the required point P. These two fundamental circles—used at least from the time of Hipparchus—will be mentioned as the "Observation Circles." It will be seen that EPF is one right line, at right angles to CP. LM, which occurs in a later figure, has been drawn parallel, and therefore equal to EF.

There will evidently be a good location of P when the two observation circles cut at right angles. $ECF = LPM$ is then 90°, and $\alpha + \beta$ is then $270° - C$; in other words, $\gamma = 90° + C$. This could have been seen on Fig. 3, for if P is anywhere on the circle O_3, then the two circles PBC, PCA cut at right angles. This is again the condition for good position suggested by Fig. 1. In this case the angles PAC, PBC, which are intimately associated with the solution of the figure, are together equal to a right angle; PMC, PLC are evidently the same angles.

In Fig. 4, are shown variations of the Collins figure and the solution by a single circle. At A draw the line AC′ making the angle α

with AB, and at B the line BC′ making the angle β with BA. Note that the line from A to C′ should be drawn in the same general sense as the line from P to B, and the line from B to C in the same sense as the line from P to A. The point so determined, C′, is the Collins auxilliary point. Join CC′ and describe a circle round ABC′, cutting CC′ in the point P, the point required.

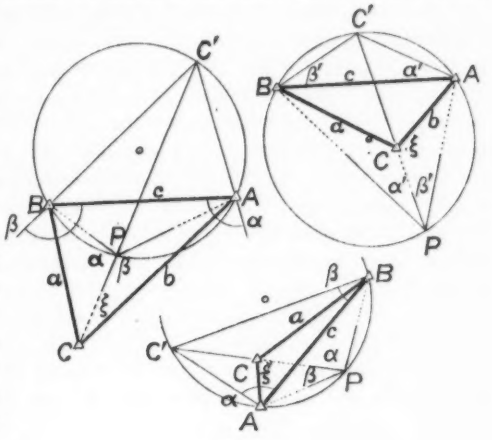

FIG. 4.

It will be noticed that the Collins circle is the "observation circle" corresponding to the angle γ, which is considered as not observed. The figures indicate also with clearness the impossible case: evidently if the circle through C′ passes through C also, the point P cannot be fixed—a conclusion so obvious that Collins, who distinguishes five cases of this problem, probably considered it not worth mentioning. In the impossible case, $C' = 180° - C$; so that the solution is well removed from impossibility when $C' = 90° - C$, or $270° - C$, the Collins circle then becoming a clear circle.

The Collins and Snellius points are antithetic; if P moves to C′, C moves to P. If C′ goes to infinity, P is the foot of the perpendicular from C on AB.

By means of the Collins point the Snellius point can be found directly on the plane-table without employing the ordinary method of trial and error and the aid of the compass. Set the alidade on AB, and orient the the table to view (*field*) B and clamp; then centering the alidade on (*table*) A, align on (*field*) C and draw the line AC′. Next unclamp the table, set the alidade on BA and clamp on (f) A; then centring on (t) B view (f) C again and draw the line BC′. Join CC′ and unclamp. Lastly, set the alidade on C′C and clamp on (f) C; then centre on (t) A and align on (f) A and draw the line AP, which meets CC′ in the required point. Centring on (t) B and alignment on (f) B gives the line PB as a check.

This method is due to Bohnenberger and Bessel, and can be employed in other problems involving resection. The fixed triangle may be enlarged or reduced; reduction may be necessary if the Collins point happens to lie off the table. Reduction or extension is accomplished by

drawing a line parallel to the base AB and employing its intercept between the two sides CA, CB. If the Collins auxiliary point is to be utilized in field work, it would be a great advantage to extend the lines between the fundamental stations to the margins of the sheet; the positions of these stations, supplied by the trigonometrical party, are laid down on the sheets while the plane-tabler is in camp, so that the running out of the lines can be done accurately, with very beneficial results as regards the speed and precision of the subsequent field work.

Rankine, in his 'Manual of Civil Engineering,' gives the Collins figure without mentioning the name of the originator. His trigonometrical solution of the same figure is as follows: Having computed AC′, BC′ by the rule of sines, solve the triangle CAC′ in which the two sides are now known, together with the included angle $CAC' = 180° - (\alpha - A)$. We thus obtain the angle ACP, marked ξ on the figures; then knowing the side b and the two angles β, ξ in the triangle CAP, compute the sides AP, CP by the rule of sines. In the triangle BCP we have also the angles α and $BCP = C - \xi$; these with the side a gives BP and a check on CP.

In working with rectangular co-ordinates the co-ordinates of C′ are computed from those of A or B. Then from the co-ordinates of C and C′ there is obtained the azimuth of CC′, which, with the known azimuth of CA, gives the angle ξ, whence the solution proceeds as above. This method gives the neatest mathematical resolution of the Collins figure.

The figs. 5 are intended for the more common solutions. The writer some years ago rearranged the formula which makes use of the auxiliary angle, putting it in a form which is perhaps more symmetrical

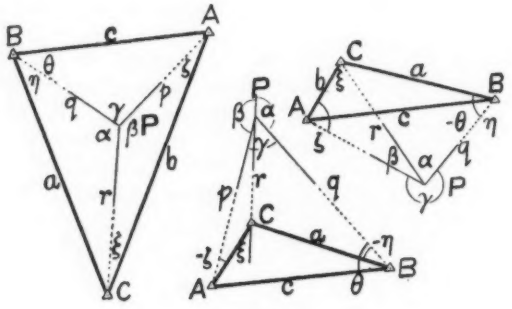

FIG. 5.

and suitable for systematic working. More symbols are introduced than are actually necessary, but the object is to attain greater compactness and symmetry, with adaptation to computation columns.

$$\text{Put } l = a : \sin \alpha, \quad m = b : \sin \beta, \quad n = c : \sin \gamma,$$
$$\tfrac{1}{2}(\alpha - A) = \alpha_1,$$
$$\tan (45^\circ + \phi_1) = m : n,$$
$$\tan \psi_1 = \tan \phi_1 \tan \alpha_1,$$
$$p = m \sin (\alpha_1 - \psi_1) = n \sin (\alpha_1 + \psi_1),$$
$$r = m \sin (\alpha_1 - \psi_1 + \beta),$$
$$q = n \sin (\alpha_1 + \psi_1 + \gamma).$$

These forms are arranged for cyclic interchange; of the three angles α_1, β_1, γ_1 of this interchange, it will be advisable to use that which most nearly approaches 45°. In terms of the angles on the figures, $\alpha_1 - \psi_1 = \xi$ and $\alpha_1 + \psi_1 = \theta$.

The geometrical interpretation of this formula is shown in Fig. 6, which exhibits a semi-graphical solution of this problem. If three rays PL, PM, PN are drawn from a point P, such that the angle MPN = 180° − (α − A), the angle NPL = 180° − (β − B), and therefore LPM = 180° − (γ − C), and if on these rays distances equal to a cosec α, b cosec β, c cosec γ, are respectively marked off, forming the triangle LMN, then the perpendiculars from P on the sides of this triangle are the required distances from P to the fixed points, which are the feet of these perpendiculars. The line LM has been already shown in position in Fig. 2.

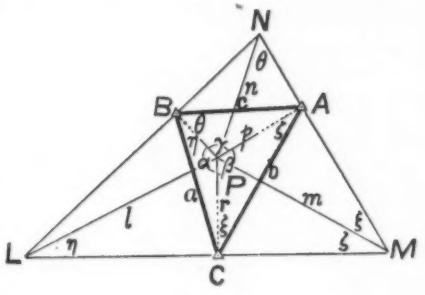

FIG. 6.

The accuracy of this construction on paper will exceed that of the tracing-paper or station-pointer method, and the fixed triangle need not be laid down; the method is, in fact, independent of the chart, and the figure can be drawn to the most suitable scale. The slight element of calculation of course adds greatly to its accuracy.

In the author's opinion the most rapid of all mathematical solutions follows from a knowledge of the approximate magnitude of one of the unknown angles of the figure. Such knowledge is obtainable from an observation of magnetic bearing of one of the lines; or the angle may be taken by protractor off a large-scale chart on which the point is laid down by the tracing-paper method; or it may rarely be taken from old measures to a station in the immediate vicinity. If the angle so obtained approximately be ζ (Fig. 9), then η is to be found from $\zeta + \eta = \gamma - C$. Now, if the two triangles BPC, CPA are solved with the rule of sines, by using these two values of ζ and η, we have two values of the logarithm of the length of CP. Divide the discrepancy between these two values

by the sum of the differences for one second of arc in the logarithms of the sines of the angles ζ and η: the result will be the correction in seconds, with appropriate sign, always obvious, to the angle ζ. Correct ζ accordingly. If the two triangles do not yet give the same value for CP (in general they will not do so), perform the operation a second time with the amended figures: the results will now usually be concordant.

The method is very simple, and, if the approximation to the unknown angle is quickly obtainable, very rapid, even if the operation has to be performed twice, for we are working along final tabulated lines throughout. For this method Shortrede's tables are excellent, since one should take out the difference of the log sine with three significant figures. Between 90° and 180° the difference of the log sine is of course negative.

The next question which arises is that of the error of the position of the Snellius point corresponding to known or estimated errors in the observed angles. In the case of known errors, we find the displacement of P as follows: If this displacement be called δP, and the errors of α, β be $\delta\alpha$, $\delta\beta$, then in terms of the symbols of Fig. 7—

$$\sin^2(\zeta+\eta)\frac{\delta P^2}{r^2}=\frac{q^2}{a^2}\delta\alpha^2+\frac{p^2}{b^2}\delta\beta^2+\frac{2pq}{ab}\cos(\zeta+\eta)\delta\alpha\,\delta\beta$$

This expression looks rather formidable, but we shall see that it is capable of geometrical illustration when $\delta\alpha^2=\delta\beta^2$. To this end it was discovered that one writer had made use of the principle of inversion, which is applied in Fig. 8. In this figure $A_1B_1C_1$ is the inverse triangle of ABC with respect to P as pole of inversion. Suppose its sides are a_1, b_1, c_1, and produce H_1C_1 to A′ so that $C_1A'=C_1A_1=b_1$. Join $A'B_1$, which we call c_2. Then it is found that the displacement of P, if $\delta\alpha=+\delta\beta$, is simply c_2 divided by twice the area of the triangle $A_1B_1C_1$ and multiplied by a constant (the square of the radius of inversion k); in other words, the displacement of P varies inversely as the perpendicular from C_1 on c_2. On the other hand, if $\delta\alpha=-\delta\beta$, that is, if the point moves on the Collins circle APB, the displacement of P varies inversely as the perpendicular on the base c_1 of the inverse triangle. Not only so, but the *direction* of the displacement of P in the former case is given by the supplementary base c_2, and in the latter case by the direction of the base c_1 of the inverted triangle. These results are analytically very elegant, and much follows from them. We see at once that the *form* of the inverse triangle is all-important in considering the error of position

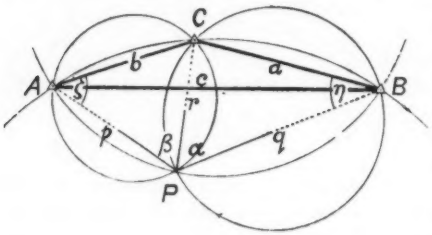

FIG. 7.

of P. For example, when $\zeta + \eta = 180°$, P is on the danger circle, as we already know. In this case the inverted triangle degenerates to a straight line, and the perpendicular or its base being therefore zero, the error in the position of P is theoretically infinite. If the Snellius point is to be well located, the inverse triangle must be well-conditioned. For example, if $\zeta + \eta = 90°$, the triangle is right-angled, and, as we have already seen, the location of P will be good. In the special case when $\delta\alpha : \delta\beta = a_1 : b_1$, the error is indeterminate: this corresponds to a neutral point.

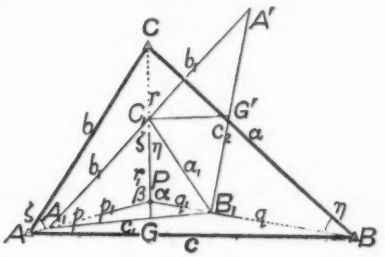

FIG. 8.

We next proceed to the more important case of probable or mean square errors, and shall give the preference to the latter, if only for the reason that mean square error presents a less favourable estimate. In this case the formula becomes—

$$2\Delta \cdot \mu(P) = \pm \mu_a k^2 \sin 1'' \sqrt{(a_1^2 + b_1^2)}$$

where Δ is the area of the inverse triangle, $\mu(P)$ is the mean square error of the position of P, μ_a is in seconds the m.s.e. of an observed *angle*, a_1, b_1 are the sides of the inverse triangle, and k is the constant of inversion. We have already given the formula in terms of the lines of the original figure. It is important at this point to distinguish between the measurement of angles and bearings. The formula above supposes that the two angles $BPC = \alpha$ and $CPA = \beta$ are observed. We might, however, with equal justice consider that the three bearings PA, PB, PC were measured. The latter is a more symmetrical method of observation, and our inquiry henceforth accordingly resolves itself into two branches following on this necessary division. If bearings are observed the formula becomes—

$$2\Delta \cdot \mu(P) = \pm \mu_b k^2 \sin 1'' \sqrt{(a_1^2 + b_1^2 + c_1^2)}$$

where μ_b is in seconds the m.s.e. of an observed bearing. In terms of the original lines this formula is—

$$\mu(P) = \pm \mu_b r \sin 1'' (a^2p^2 + b^2q^2 + c^2r^2)^{\frac{1}{2}} / ab \sin (\zeta + \eta)$$

It is therefore apparent that, remote from the danger circle, the error of position of P varies roughly as the square of the mean distance from the fixed stations.

These formulæ, then, provide expressions for the displacement of P corresponding to estimated errors in the angles or bearings, whereby it is possible to determine, with sufficient exactitude, the error of location of P without resorting to field measurement by other methods.

These expressions for the error of location of P enable us to proceed to the last part of our inquiry, namely, the investigation of the best site for P. Dealing first with the case where two angles are observed, we find by analytical methods that, when the error of P's position is a minimum, not only must $\zeta + \eta$ be 90° or 270°—a condition already frequently mentioned —but in addition a_1 must equal b_1; in other words, the inverse triangle must not only be right-angled, but its sides must be equal. This interpreted in symbols of the original figure implies that $p : q = b : a$; that is to say, the ratio of the distances of the Snellius point from the apices A, B of the fixed triangle must be as the adjacent sides. The Snellius point in this case lies on the well-known circle which divides the base internally and externally in the ratio of the sides.

This, then, is a new condition. In some form it crops up in similar investigations in all problems of resection; it may be known as the "condition of equality of position," by which is implied that, if the error of location of a resected point is to be a minimum, the point must not be more favourably situated with respect to one fixed point than to another. More generally, in two-point problems, one resected point must not be more favourably situated than the other with respect to the fixed stations—a principle of wide application.

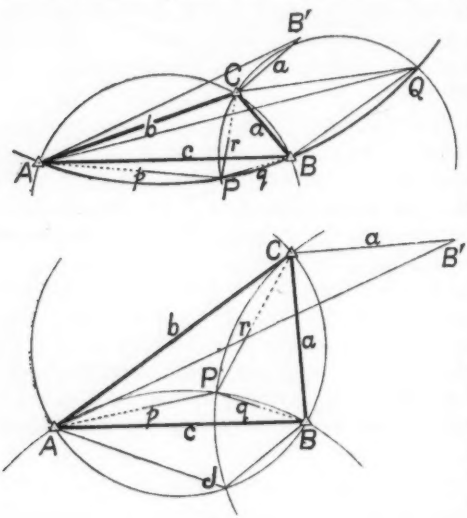

FIG. 9.

In Fig. 9, P is placed at the crossing of the circles which have been found to govern the case of minimum displacement when the two angles are observed. APBQ is the clear circle determined by the condition $\gamma = 90° \pm C$; PCQ is the "locus circle," as it will here be shortly named, corresponding to the condition of equality of position. Both circles cut the danger circle at right angles, as might have been anticipated. These two circles cut again in Q, which might thus be expected to claim equality with P; but this is not so. With respect to Q the inverse triangle is equal-sided and rectangular, but its area is much less than that formed from P. P is then the sole position of minimum displacement.

The locus circle cuts the danger circle again in J, which is a neutral point.

The position of P may be determined geometrically in a simple manner. Erect CB′ at right angles to CB and equal to the latter; join AB′. Then protract the angle BAP equal to B′AC and ABP equal to AB′C.

The minimum displacement of P is

$$\pm \mu_0 r^2 \sin 1'' \, c/ab$$

We now come to the more interesting case where the three bearings are observed. Here mathematical analysis proves that for minimum displacement of P the inverse triangle must be equilateral, and in consequence $pa = qb = rc$. Thus in this case P is the intersection of three circles, each of which is the locus of an apex of the fixed triangle when the opposite side and the ratio of the adjacent sides are constant. The geometry of the figure is illustrated in Fig. 10. If O_1, O_2, O_3 be the centres of the three locus circles, O_1, O_2, O_3 are collinear, and if O is the centre of the danger circle, O, P, Q are collinear; further, each of the locus circles cuts the danger circle at right angles. These results are well known. Many of the relations of the figure are evident from inversion, since, if two curves cut one another at a certain angle, their inverse curves cut at the same angle. Thus the danger circle inverts into the circle $A_1B_1C_1$, and the locus circles invert into the diameters A_1H_1, B_1I_1, C_1J_1; since the diameters cut one another at 60°, the locus circles cut one another at 60°. Again, if the observation circles, which are not drawn in the figure, are considered, it is seen that the circle BCP inverts into the line B_1C_1; and similarly the two circles CPA, APB invert into the lines C_1A_1, A_1B_1. Since these lines both cut one another and the invert of the danger circle at 60°, the observation circles cut one another and the danger circle at 60°. The analogy with a well-conditioned triangle is obvious: the observation circles in this case are all well-conditioned as to their cutting of the danger circle. All the circles mentioned cut all the others at either 30°, 60°, or 90°. The observation circles are all clear circles, but not exactly in the sense hitherto used; they were formerly considered clear if they cut the danger circle at 90°. But only two can cut at 90°; here three are cutting at 60°.

For the same reason as was given in the case of angle observation, Q is not the most favourable position. But P and Q are together unique in this, that they are the only two points from which the original triangle inverts into one which is equilateral; P and Q are in fact special centres of inversion for the triangle.

H, I, J are all neutral points, and $A_1J_1B_1H_1C_1I_1$ is a regular hexagon. P then occupies precisely the same relation to the triangle HIJ as to ABC. These neutral points represent points of weakness in the danger zone: in their vicinity the Snellius point may approach nearer to the danger circle

than elsewhere; in other words, a point moving off the danger circle in their vicinity improves its position, as regards resection, with maximum rapidity. The command of position from the neutral points is not, however, equally strong; for example, the Snellius point would have to move farther away from J than from I to secure equally good location. If the fixed triangle, be inverted from J, say, it will be found that the triangle becomes a line bisected by JC.

Fig. 10 shows a geometrical construction for P. On AB describe an equilateral triangle ABC″ and join CC″. Draw the angle BCP equal to ACC″ and CBP equal to AC″C, thus obtaining P. Or we may find P by

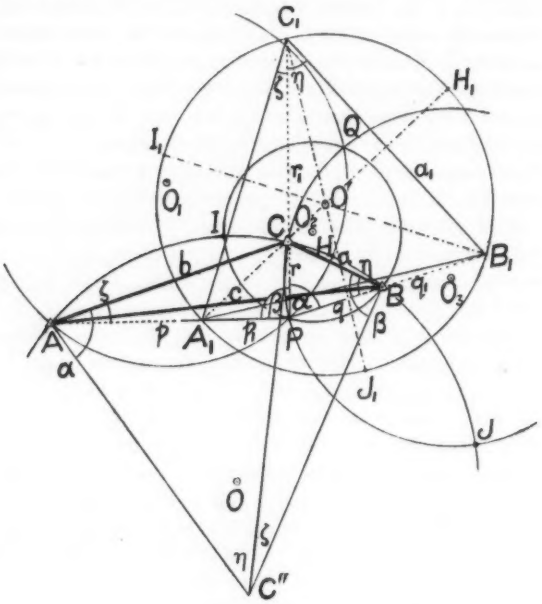

FIG. 10.

the method of Fig. 9. Draw CB, in this case making an angle BCB′ = 60°; the remainder of the construction is as before. In this case the Snellius point in its best position is on the base when C = 120°; in the former case, that of angle measurement, it is on the base when C = 90°.

When bearings, or as they are sometimes termed, directions, are measured, the minimum displacement of P is $\pm 2\mu b \sin 1'' s^4/abc$,

where $s^2 = ap = bq = cr = abc/\sqrt{\{a^2 + b^2 - 2ab \cos (60 + C)\}}$

The Second Problem.

Every surveyor in the field is rapidly made acquainted with the difficulty of finding a spot from which a sufficient number of surrounding stations are visible. This is more particularly true of a country broken by deep valleys or numerous ridges. To find connections for points in these valleys or in ridge-divided plains, in which lie as a rule the more valuable areas, is a task which is constantly confronting the observer. It follows, therefore, that it may almost be said of any method of resection that, *ceteris paribus*, its merit is in inverse proportion to the number of fixed stations required. This statement is more strictly warranted in the case of trigonometrical interpolation than in plane-table work, for it may be said that *practically* the plane-table demands a minimum of three stations.

The present method, involving only two fixed stations, is therefore entitled to second place; although not so generally used as the first, it is usually employed in work of a somewhat higher class. The first method is above all suited to the plane-table; the second is not directly applicable to the plane-table, but is eminently adapted for the theodolite. It has been so largely used in India, particularly in the Himalayan and trans-frontier region, and more especially in the deep valleys of this region, that it may be known as the Indian Problem.

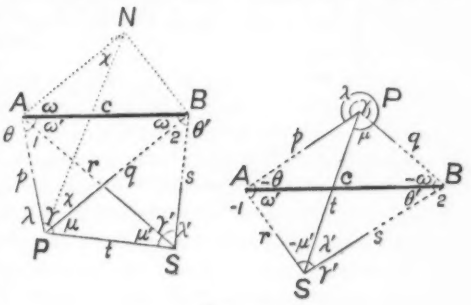

FIG. 11.

In Fig. 11, A, B are the two fixed stations and P, S two points resected from them, the observed angles therefore being as marked γ, μ, γ', μ'. Now from these angles we can compute the ratio PB : PA, or as marked $q : p$. Hence in the triangle APB there are known the angle APB $= \gamma$ and the ratio of the adjacent sides; wherefore the base angles ABP $= \omega$ and BAP $= \theta$ can be computed. Major R. A. Wahab, R.E., used an auxiliary angle χ, with the following geometrical construction: Draw AN parallel to PB, and drop BN perpendicular to AN. Then the angle ANP or BPN is the angle χ. Having computed χ he thence derives ω, = BAN or ABP. Knowing ω, or any one of the angles at the fixed stations, we thence derive all the other angles of the figure, whence the lengths of the lines are derived by the ordinary rule of sines.

Here again it is apparent that the solution depends on that of a triangle in which one angle and the ratio of the adjoining sides is known —the same difficulty which revealed itself in the case of the first problem.

The various artifices which are used arise from the simple fact that these data in the triangle do not permit of pure logarithmic computation without supplementary aid. Here again, then, the auxiliary angle ϕ may be employed. If we put

$$\cot(\phi + 45) = p : q = \sin \mu' \operatorname{cosec}(\gamma' + \mu') \operatorname{cosec} 1 \sin 2$$

then

$$\tan(\omega + \tfrac{1}{2}\gamma) = \tan \tfrac{1}{2}\gamma \tan \phi$$

This gives ω, from which the lengths of the lines follow as before.

Perhaps the most obvious solution is that by Colonel T. F. B. Renny-Tailyour, R.E. It is immediately apparent that the geometrical solution is merely a question of scale, since, if the length PS were known, the figure could be immediately plotted. Accordingly the geometrical solution entails merely the adoption of a provisional length for PS, the plotting of the corresponding figure by means of the observed angles, and the enlargement or reduction of the figure in the proportion of the true length of HB to the length obtained from such a plotment.

This principle is easily applied trigonometrically. Assume that PS is one foot or one metre (according to the units employed), and compute the corresponding length of AB. Then add the difference between the logarithm of the length thus computed and the true logarithm to the logarithms of the lengths of all the computed lines; the result is the solution of the figure.

It is not to be supposed that this method shortens the trigonometrical computation. We have here to solve the reverse problem, that of finding the length of AB when the two points A_1B are *intersected* from P, S; and this solution again involves the cosine formula, that is to say, the formula for the solution of a triangle given two sides and the included angle. We may note in passing that this problem of intersection is known as Hansen's on the Continent. Hansen's paper was published in 1841; since, however, the solution was given for the resection by "a Member of the Philosophical Society of Oxford" (whose name cannot be found) in the *Philosophical Transactions* for 1685, it is obvious that Hansen has no claim to originality.

The problem may be simply solved by means of an approximate value of one of the angles, say ω. Let the value of $\not{p}$, thence computed directly from the triangle ABP, be $\not{p}'$, and that similarly computed through the the triangles ABS, ASP be $\not{p}''$; then

$$\Delta\omega = (\log \not{p}' - \log \not{p}'') / \{\nabla(\omega) - \nabla(2 + \omega)\}$$

where $\Delta\omega$ is the error in seconds of the approximation to ω, and $\nabla(\omega)$, $\nabla(2 + \omega)$ are respectively the differences for one second in the log sine of the angles ABP $= \omega$ and ABS $= 2 + \omega$. Perform the operation twice if necessary.

The displacement of either resected point corresponding to known or mean square errors of the observed angles is calculated without much difficulty, but will not be given here.

The position of minimum displacement, corresponding to a common error in the observed angles, is almost obvious. Since the measured angles are placed symmetrically in the figure, it is apparent that neither P nor S can occupy a preferential position with respect to the fixed stations A, B. We can here invoke our principle of "equality of position." It follows that the figure for minimum displacement must be rectangular and symmetrical. The two forms are shown in Figs. 12, where it is almost obvious that the crossed form must give the better fixing for a given length of AB.

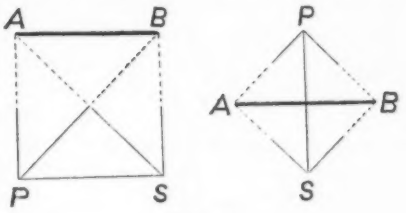

FIG. 12.

This problem is not directly applicable to the plane-table, as heretofore remarked. If the solution be desired on the plane-table, it is necessary to adopt a provisional base, which may be chosen to represent as closely as can be estimated the line between the resected points in length and direction. Working from the two stations, we thus obtain a figure which must be corrected in dimensions and orientation to agree with the line between the fixed stations.

The PRESIDENT: I regret the absence of our Chairman this afternoon. Dr. Mill is still suffering from his recent accident, and I fear he will not be available for some little time. We are to have an address this afternoon on a highly technical subject from a gentleman who is particularly well qualified to deal with it, for Mr. McCaw has had much experience of geodetic survey in various parts of the world, especially in South Africa and on the Uganda-Congo boundary.

(*Mr. McCaw then read the paper printed above, and a discussion followed.*)

Lieut.-Colonel LYONS, R.E.: I am glad this question has been treated by Mr. McCaw, because there are many of these investigations on surveying which do not come before surveyors in this country as often as they might, and especially those that set forth clearly the effect of the errors which must occur and the necessity for taking them into account in selecting a method. I hope that, when the paper is published, Mr. McCaw will give fully the references to those papers by Townley and Bessel and others that he has quoted, for, as he says, they are not generally known in this country, although they are quoted freely in the principal text-books on the Continent. The history of the development of surveying is very interesting, as the case which Mr. McCaw cites has shown, but the whole subject well deserves to be followed up more thoroughly than has been done of late years in this country. Mr. McCaw says that resection is not applicable or would not usually be used in cadastral survey, but perhaps he is using the word "cadastral" in a limited sense, because resection and somewhat elaborate methods of applying it are very generally used in the cadastral surveys of Europe; for instance, where it is necessary to obtain co-ordinates of such resection points for use in the further development of a survey of landed property. Such a cadastral survey is one

in which all the property boundary points have their co-ordinates determined as part of the work, and I can imagine a good many cases—for instance, on the hill slopes of Cyprus—where these resection problems would be of great value when handled by a surveyor fully conversant with their meaning and their limitations. I am afraid I am not able to discuss the paper in detail, for it is a long and somewhat intricate and very valuable one, which I would like to compare in detail with similar statements on the subject, such as may be found in Jordan's 'Handbook,' where the subject occupies twenty-five pages. Where the accurate position of many points is wanted, it is an important question, and for that reason—although not immediately so at present—I am certain it must be important for surveyors in colonial areas, where the registration of land titles and their location on the ground are in force.

Mr. A. E. YOUNG (formerly of the Federated Malay States Survey): The paper has been very interesting, and I hope we shall soon see it in print and be able to study it at our leisure. I have used the problem in cadastral surveying to check the bearings of traverse work. If you can see three or more stations from a traverse point you can observe the angles, and although, with an ordinary traverse-survey theodolite, you may not get the angles near enough to fix the point and get its co-ordinates accurately, you can work out bearings near enough to check the angular error of the traverse, and I have found it useful in that way.

Mr. HINKS: I have naturally been very much interested in this paper, and there has been strongly in my mind, while listening to Mr. McCaw, the case, which you will remember very well, of the Peru–Bolivia Boundary Survey Report we have been editing. They started a triangulation upon the high plateau south of the watershed of the Andes, determined the position of a number of inaccessible snow-peaks, and then had to start again in the north, connecting their triangulation north and south purely by resection from those lofty and inaccessible snow-peaks that had been intersected from the south. That is, on a grand scale, an example of the process to which Mr. McCaw's theories refer very directly indeed; and it seems to me that it will be of considerable interest at some time, when one has more leisure than at present, to study the solution of that problem as it might have been made, supposing they had been armed up on the high plateau with all the geometrical refinement and elegance with which Mr. McCaw has now provided us. Another case which occurs to one is the connection between India and Central Asia. It has been done recently with considerable difficulty by running a chain of triangles, rather of the second class, by the only route practicable for a direct chain. But the problem will always be presenting itself, whether a stronger connection between the triangulations of Europe and Central Asia could not be made by resection in Central Asia from the long series of first-class peaks intersected from the plains of India, or from the lower hills of the Himalaya. At any rate, it is quite clear that there in the future, when one is able to extend surveys into the less accessible parts of the ranges, we shall have a glorious field for the practice of this method. Finally, I should like to remark upon the curious fact that, coincident with the restrictions in paper and printing both by reason of excessive cost and also by the action of the controllers, we are in this Society in the painful position of accumulating a large number of most important papers upon different problems in survey that we cannot at present publish. We have had the ambition for some time in the Research Committee to publish a series of survey pamphlets; and Mr. McCaw's is certainly the fourth, if not the fifth, important survey paper that will be lying in my room awaiting full publication

until such time as conditions after the war allow. The way in which these important survey publications are at present piling up in the Society is striking, and a very good augury for the future.

Mr. REEVES: Although much has been written on this subject on the Continent, it has been inadequately dealt with in English works on surveying, and Mr. McCaw's paper will be of great service to all those who desire to use resection to the best advantage. The graphic solutions are, of course, well known to the topographer, but the more accurate method of theodolite resection is not so well understood. Surveyors could often have done better work if they had been more at home with the method. There are occasions, such as in mountains where movement is restricted and difficult, when it is of the greatest importance, and at times practically indispensable, as in the survey of the Siachen glacier by the late Captain Grant Peterkin. Here rounds of angles to peaks previously determined by the Survey of India gave resected points for the plane-table. A surveyor should understand what conditions are likely to give him the best fixings, and here Mr. McCaw's paper will be especially useful; but the choice is often very limited, and a man has to do the best he can. In such a case it is well to know what accuracy his work will yield, and this he will be able to do if he has studied the subject as set forth by Mr. McCaw.

It is doubtless true that in very favourable cases resection should in theory be as satisfactory as triangulation, but I think that in practice this would rarely be the case. In the best of cases resection is a somewhat roundabout method, with its computation of auxiliary angles, and I feel sure that a surveyor would still be well advised to use resection only when he is unable to use ordinary triangulation.

Some interesting solutions of the problem are given in Puissant's 'Traité de Topographie' of 1820, placed on the table, as I thought some might like to look at it. His first solution is much the same as that generally found in text-books, except that the triangles are solved by spherical trigonometry instead of plane, which is desirable for far distant points.

The PRESIDENT: I may perhaps add a word to the history of this method of determining position. Mr. McCaw said that he thought it had been first of all applied by the Survey of India. That is so. I think I may say that I was the first to apply it. The conditions were as follows: From a trigonometrical series of the first class which runs pretty nearly east to west through the Punjab a great number of snow-peaks on the main range of the Himalaya had been fixed, some with very considerable accuracy, some more or less doubtfully. There arose a question of joining up the Indian Surveys with those of Russia in the Pamirs. When we had wriggled our way through the Himalaya on to the Pamirs, you can easily understand that it was exceedingly difficult at first to recognize the peaks that had been fixed from the south. By dint of considerable climbing and trouble we did succeed from the Pamirs in identifying a certain number of those peaks, and we found that in the process of identification the plane-table was essential—three of them we got to a certainty. Then came the problem of fixing our position by resection, and that, I think, was the first important occasion on which the method had ever been used. We succeeded; and we were enabled thereby to determine in those very difficult regions a latitude with more accuracy than we could have effected by absolute astronomical determination, because of the attraction of the southern mountain masses on the level. This was exceedingly important because the delimitation of the boundary between Russia and Afghanistan was dependent on latitude, and it was very necessary to determine whether one particular range, which ran pretty nearly

east and west and which formed a very definite and excellent range for the boundary, was above, or below, a certain latitude. Our trigonometrical determination differed considerably from the Russian astronomical position; but scientific Russian surveyors were not prepared to back an astronomical determination against a trigonometrical. Comparatively recently triangulation has been carried across the Himalaya up to the Pamirs. The series could not be called first class, by reason of the exceeding narrowness of the valleys up which the surveyors had to work. But it was direct triangulation. Having reached Lake Victoria, and determined independently the position of the initial boundary-point which we had ourselves determined by resection, the difference between us proved to be exceedngly small, so small that they expressed some surprise. For my own part I was not surprised, because I felt perfectly convinced that we got very nearly the right results. But I may point out that if three peaks have been fixed, as ours were, by intersection from a distance with comparatively narrow intersections, it is probable that the computed azimuth between them will be very uncertain. Consequently we took extreme trouble when we were up on the Pamirs to get an azimuth by astronomical observation, taking the mean of a great many determinations. By the introduction of that azimuth we saved the situation, and I must insist upon it that any one who makes use of this method (trigonometrically, not graphically) for fixing his position must be very careful to determine his azimuth at the same time. I am glad to be able to add that little bit to Mr. McCaw's story of the use of resection, and I hope that in due time we shall see the whole theory set out properly in our publications and be able to study it a little more closely. I will ask you to thank Mr. McCaw sincerely for a very interesting paper leading to a most useful discussion.

REVIEWS

EUROPE

Social Life in Britain from the Conquest to the Reformation.— G. G. Coulton. Cambridge: The University Press. 1918. 15*s. net.*

A BETTER text-book for the study of our early social life could hardly be devised than this, of which Mr. Coulton is the skilful compiler, since it consists wholly of such extracts from mediæval literature as are calculated to throw most light on the subject. The extracts are mostly in prose—although verse is drawn upon, here and there, when necessary—and are grouped under fifteen sections, giving an extremely comprehensive view of mediæval life. When the originals are in English the old spelling is retained, thus keeping, as far as possible, the mediæval savour. Of the large proportion of extracts from Latin and old French writings many, the compiler tells us, are here translated for the first time. Use has been made however, where possible, of old translations.

In the first section on "Land and Manners" (containing Trevisa's translation (1326) of Higden's *Polychronicon*), the dryer geographical facts are enlivened with accounts of phenomena which have since disappeared from these islands. Under the Peak of Derbyshire, for instance, "There bloweth so strong a wynde out of chenes of the earth, that it casteth up agen clothes that men casteth yn." In many places, "There beeth salt welles fer fram the see, and beeth salt alle the woke longe, forto Saturday at none: and fresche

from Saturday at none forto Monday." A pond existed, "i-closed aboute with a wal of tyle and of stoon. In that pond men wascheth and batheth wel ofte ; and everiche man feleth the water hoote or colde, right as he wolde hymself." But besides telling us of these wonders, Higden shows a keen observation of the physical and social characteristics of the British Isles.

A striking description is given of the linguistic difficulties of the time. In addition to the three dialects Englishmen had originally to cope with—inherited from their ancestors, "the thre manere peple of Germania"—the language had become mixed with Danish and Norman French and was much mpaired, we are told ; "and som useth straunge wlafferynge, chiterynge, harrynge, and garrynge grisbayting," a sentence which lends some colour to the statement. Of the manners and doings of the countries of "Engelond"—as topographically diverse and strange to each other as were formerly those of the citizens of north and south Italy—there is much criticism that is trenchant and amusing.

Particularly interesting, geographically, is the section on "Wayfaring and Foreign Travel," with extracts illustrating the subject on many sides, from Trevisa's description of the helplessness of a blind man on the road, to Fitzstephen's account of the pomp of his master Becket's missions in France. Much curious detail is given of the cost of travel, the food, the routes and the like ; while the dangers and wonders encountered by travellers show England of the Middle Ages to have been a stranger place than Tibet or Central Africa of to-day.

An Old Gate of England: Rye, Romney Marsh, and the Western Cinque Ports.— A. G. Bradley. London: Robert Scott. 1918. *With Illustrations by Marian E. G. Bradley.* 6*s. net.*

Mr. Bradley has written another of his entertaining topographical books, this time about Rye and the surrounding country, of which he shows a knowledge that could only result from long acquaintance and real affection. "Rye," he says, "is unique. There is no doubt whatever about that. The better you know your England the more obvious becomes this simple fact." Naturally the book is not merely descriptive, but contains much historical reminiscence, and Mr. Bradley's account of the part played by Rye and the surrounding towns in the days when the Cinque Ports were at the height of their prosperity, is written with a dry humour that succeeds in bringing their rather truculent burghers and sailors very near to us. Especially delightful are the descriptions of the "long green sweep of the Marsh, with all its shifting lights," in this corner of the "old, old England." Every village and church, almost every old house, becomes for the reader alive with tales and histories, not so much of the nobility as of the common village folk. After dealing fully—both geographically and historically—with Rye and Winchelsea, the country and its villages between Winchelsea and Hastings is thoroughly explored. Then, by way of the steep road out of Hastings over Fairlight, the author takes us through the outlying villages to Brede and Northiam ; from Northiam we return through Wittersham, Iden, and Playden to Rye. From Rye we start out again northwards to Brookland and Lydd, and across the Romney Marsh to Dymchurch and Lympe. The text is supplemented by excellent pen and ink sketches by Marian Bradley, and the book is to be recommended both to those who know and those who do not know Rye.

British Foreign Policy in Europe.— **H. E. Egerton, M.A.** London: Macmillan & Co. 1917. 6*s. net.*

Prof. Egerton gives us a word of apology in his preface for leaving colonial and imperial history to write on European policy. Yet his book, which is a most useful one, renders the apology unnecessary. And moreover it is certain that British foreign policy cannot be fully understood and explained save by a historian with a grasp of British imperial history. For this reason it is somewhat to be regretted that Prof. Egerton has confined himself so largely to the nineteenth century. The roots of British foreign policy lie further back, and the interests, the ideas, the instincts, one might say, out of which it has grown must be traced through the age of the Reformation and of the struggle for maritime and colonial power in the sixteenth, seventeenth, and eighteenth centuries. Our religion, our island position, our constitutional liberties, our ever-growing commercial interests, our increasing dependence on imports of food and raw materials, and our interest in the security of the great routes of trade, have been the essential factors determining the nature and objects of our policy. The part we have played in the political struggles of the Continent has varied with changing circumstances, but our outlook has been consistent and our policy continuous through it all. Moreover, our policy has necessarily been affected by the changes which general progress in industry and transport and the opening up to Western civilization of new regions of the world have been ever bringing—an aspect of the subject which Prof. Egerton does not sufficiently emphasize. Hence, while this is a lucid, interesting, and helpful book, it cannot be called a profound study, and perhaps its chief merits are its full account of some aspects of our nineteenth-century policy and its extensive quotations of the views of eminent British statesmen. That Prof. Egerton should reserve English claims by sea for a separate chapter at the end of the book is an indication of the line of treatment he has chosen. A connected survey of this important subject has, of course, its advantages; yet in a study of British foreign policy it ought not, surely, to be separated from the main texture of the argument. E. A. B.

AFRICA

The Desert Campaigns.— **W. T. Massey.** London: Constable & Co. 1918. Pp. xvi. and 198. *Illustrations by* **James McBey.** *Sketch-map.* 6*s. net.*

Mr. Massey's business is to describe the campaigns of 1915–16 in the Sinai Peninsula and the Libyan desert, and he tells his story in straightforward readable style. He makes no attempt at a formal description of the deserts, and the one sketch-map given is not adequate, but his narrative brings out clearly the character of the country, and will help a good many people better to appreciate the remarkable achievements of the Egyptian Expeditionary Force. From the time of the Pharaohs many armies have crossed Sinai; probably never since the Exodus has the peninsula had to support for a lengthened period so large a number as the troops encamped in it throughout 1916. Mr. Massey shows how great were the transport and supply difficulties overcome. In heat almost unendurable, and in "icy cold" in winter nights, the railway was pushed on eastward from the Suez canal at Kantara through heavy and often shifting sand, and with it went precious pipe lines carrying the Nile water (chlorinated) almost to the gates of Gaza. The railway and the pipe lines, these were the means by which the occupation of Sinai was

rendered possible. The Turkish invading forces were smaller, and were not intended to remain in Sinai if their attacks failed, but they were equipped with all the means German science could devise for a rapid transit of the desert, and they had a railway base on the Sinai border.

How quickly the desert obliterates the traces of man's occupation is brought out when we read that a short time after their abandonment "sand has blown over camping-grounds which had accommodated divisions, and not a sign of their presence remains." But the railway (built by the fellahin) which now affords direct communication between Cairo and Jerusalem, is there to testify to man's supremacy over the desert. Few will be the travellers who will now take the old caravan route.

The chapters devoted to the campaign against the Senussi are noteworthy, apart from the military record, for an account, which might be fuller, of Siwa oasis as it is to-day, and for the evidence that where the sand is hard or the desert stony motor cars are invaluable as means of transport. The book is enriched by the reproduction of some two dozen of Mr. James McBey's drawings. Those of desert scenes are vivid and arresting. Heat, solitude, space, as well as the ever-present sand, are all in these drawings.

F. R. C.

AUSTRALASIA AND PACIFIC

A Contribution to the Phytogeography and Flora of the Arfak Mountains (Dutch North-West New Guinea).— L. S. Gibbs. London: Taylor & Francis. 1917. Pp. iv. and 226. *With* 4 *Plates and* 16 *Text Figures.* 12*s.* 6*d. net.*

Miss Gibbs prefaces her systematic account of the plants collected in the Arfak Mountains and at various places on the coast of north-west New Guinea by a most interesting sketch of the physiographical features and vegetation met with on her journey from Wariap on the coast to the Angin Lakes, which lie 40 or 50 miles from the east coast of the north-west Papuan peninsula at elevations of 7000 and 8000 feet, and are separated by the Koebré Mountain (9000 feet).

The whole of the north-west peninsula is mountainous, and on its north coast the hills rise more or less abruptly from the sea, but on the east coast they are separated from the shoreline by a plain of coral limestone—the *korang*—forest-covered, but of very recent elevation. The physiographic features of the country on this east coast correspond very closely to the types of vegetation. The shoreline is sparsely inhabited, and apart from a few mangrove swamps consists of big stones, shingle, and loose sand. Along much of the shore large blocks of coral lie at the water's edge, and against these the surf beats ceaselessly, while the dip of the beach is too steep for the landing of native praus. Where the beach is sandy the ordinary strand vegetation of the eastern tropics is developed, but where it is narrow and steep there is a dense growth of the strand trees, with huge *Barringtonias* lying prostrate or semi-prostrate over the sea, young plants of *Pandanus*, *Crinums*, *Dracænas*, and myriads of "prostrate *Barringtonia* seedlings attached by the one anchor root, all pointing seawards and bearing witness to the force of the great waves retreating from their rush inland."

The korang formation bears a forest consisting of *Terminalia catappa*, *Ficus*, *Artocarpus*, etc., with some epiphytes and root-climbers, but very little undergrowth, sodden leaves filling up the interstices of the porous korang. This region is subject to frequent inundations from the rivers, and

is sterile and uninhabited except where islands of soil have accumulated or alluvial deposits have been formed by the rivers, and in such tracts there are extensive plantations. Here and there are groups of huge Pandanus trees, 100 feet high, which "possibly represent the first vegetative covering of the korang, displaced later by more rapidly growing dicotyledonous trees."

The foothills of the Arfak mountains are covered with secondary forest, which possesses a much more varied flora than the korang and many signs of old cultivation. The ground is rocky and broken, but with plenty of soil. The existing houses and *kebuns* are on the ridges. The cultivation is rich and varied, including sweet potatoes, gourds, plantains, papayas, sugar-cane, and, at higher altitudes, maize and tobacco.

Above 7000 feet there is low mountain forest, with many interesting conifers such as *Dacrydium*, *Phyllocladus*, *Libocedrus*, and *Podocarpus*. The upper part of this forest, limited to the highest points of the ridge, is of mossy type—the trunks of the small stunted trees and the ground between swathed in long moss which stands out straight from its supports, rigidly turgid and generally in vegetative condition. The open spaces are due to fires, and of these the open summit of Koebré mountain is occupied by a lichen (*Cladonia*) association on the hard granite gravel, replaced by stretches of short bracken fern (*Pteridium aquilinum*, var. *lanuginosum*) or *Gleichenia vulcanica*.

Miss Gibbs collected over 330 species in the Arfaks, one hundred of them being new to science, with one new family and five very distinct new genera. Her main phytogeographical conclusion, confirming and extending those of some of her predecessors in this field, is that New Guinea is the real centre of distribution of many so-called Polynesian, Australian, and to a less extent Malayan types, of which the Papuan species are older and show extraordinarily pronounced specific differentiation. This conclusion is supported by a considerable range of evidence, geological and taxonomic. An interesting ecological point is that what the author calls the open "opportunity" plant associations, *i.e.* the vegetation of spaces kept open by fires, are characterized, not by aliens as is so commonly the case in the tropics, but by indigenous or endemic ombrophobous (shade-avoiding) plants, and this is in line with the general conclusion that the Papuan flora combines the characters and must be considered as representing the original stock of the Malayan, Polynesian, and Australian floras. If New Guinea had been investigated botanically before the neighbouring regions we should have realized earlier the dominance of the Papuan elements in their floras. A. G. T.

GENERAL.

James Geikie, the Man and the Geologist.— Marion I. Newbigin and **J. S. Flett.** Edinburgh: Oliver & Boyd. 1917. *7s. 6d. net.*

The writing of biographies of men of science grows yearly more difficult, as the lives of their subjects become more professional. The travels even of a geologist are ceasing to be pioneer explorations, and are only such holiday journeys as the restricted income of a modern scientific man will permit. Even the production of an important book is no longer what it was in the days of Darwin and Lyell.

In the case of James Geikie something of the heroic period still remains, which will have disappeared in the case of his successors. Essentially an outdoor geologist, who exchanged the Survey for the University with reluctance —living at a time when burning scientific questions could still be discussed in books readable by the educated general public—he forms a link between

pioneer and professional whose life can interest many who never knew the man, and his biographers have presented it in a manner to arouse interest. We are presented with the picture of a healthy and vigorous mind, whose scientific bent did not exclude artistic, musical, and poetical ability; and a character which engendered respect and devotion in his students.

Of his scientific work the most important is that embodied in his famous book 'The Great Ice Age.' Brought up among the evidences of the glacial period with which Scotland abounds, it was natural that he should throw his main energies into the elucidation of these. But he was quite free from that insular outlook with which British geologists have been at times reproached, and was familiar with the researches of geologists of other lands, with many of whom he was in correspondence, to the mutual advantage of both sides. As a glacialist he was the champion of two main ideas—that of land-ice *versus* floating ice as the important agent of glaciation, and that of an alternation of milder interglacial periods with periods of severe glaciation. The former idea may now be considered triumphant, while the latter is still controversial.

James Geikie was by no means exclusively a glacialist, however. His contributions to tectonic geology, though mainly expositive or critical, are important; and his later book on 'Mountains: their Origin, Growth and Decay,' shows a mastery of this difficult subject, and should not be without influence on the future development of tectonic geology. The last book from his pen, 'The Antiquity of Man in Europe' (1914), dealt with another subject which he had made specially his own. A. M. D.

A travers les Continents pendant la Guerre.— Joseph Joubert. Paris: Berger-Levrault. 1918. 3*s.* 6*d.*

This small volume consists of a collection of articles written with reference to events of the day and reprinted as they were written, even where subsequent events have rendered views expressed in them out of date. The articles themselves, however, though grouped according to subject and not date, are all dated, so that any historical inquirer may take them for what they are worth as indicating the feelings and opinions of prominent men, at least in certain circles, worthy of consideration. In the preface the author lays great stress on the *rôle* which that "master factor geography" has played in various ways in this war from its beginning, and several of the articles are inserted under the general heading "Questions Géographiques." And the geography he means is geography "in its proper sense and wisely synthetic, not including ethnography, political economy, linguistics, and what not . . . , but limited to telluric study, to the relief of the land, to the oro-hydrographic systems, and, with a view to the future peace negotiations, to a profound study of the frontiers of every country engaged in the hostilities" (pp. x.–xi.). But it is difficult to see how this last study is to be pursued without reference to at least one of the subjects which the author has excluded from geography, as well as perhaps other considerations belonging to various subjects comprehensively dismissed under the "what not" (*que sais-je*). For example, on p. 123, in one of the articles included under the heading "Questions Géographiques," he tells us that, in the opinion of several publicists whom he cites, the minimum claim that can be formulated by France as a condition of peace is "the entire territory on the left bank of the Rhine to the entrance of that river into the Kingdom of the Netherlands, whether that territory is to be annexed solely to France or in part to Belgium;" and the same claim is repeated with the support of other authorities (but with no reference to Belgium) on pp. 171–3, in an article

dated 14 June 1917, originally contributed to *Le Rhin français*, and here inserted under the general heading "Foreign Politics in Europe." In making such claims on the basis of geography we can well understand the exclusion from that subject of ethnography and linguistics, but how about political economy? One of the reasons urged for the annexation is that thereby the whole of the Moselle basin would become French, and, "as M. Sardou says, 'it is useful to emphasize all the economic importance attached to the coal-basin of the Sarre.'" G. G. C.

THE MONTHLY RECORD

EUROPE

John Adair and his Maps of Scotland.

LITTLE is generally known of the work of John Adair, author of some of the earliest maps of the Scottish counties, preserved in MS. in the Advocates' Library, Edinburgh, the British Museum, and the Bodleian at Oxford. What can be learned of the man and his map-making activities is summarized in the *Scottish Geographical Magazine* for February last by Mr. Harry R. G. Inglis, who has long made a study of the history of Scotland's cartography, of which he probably knows more than any one now living. The sources of information are, firstly, the maps themselves, which are described as models of workmanship in almost every respect—minute, clear, and artistic; and secondly reports and papers preserved in the Register House, Edinburgh, many of them relating to the difficulties and contentions which arose between Adair and Captain Slezer, author of the *Theatrum Scotiæ*. The chief maps remained in MS. until long after Adair's death, and the first to bear a date is that of East Lothian (1682), though this was very likely preceded by the undated maps of Midlothian, West Lothian, and Clackmannan. The rest of the maps bear dates between 1683 and 1686 inclusive, with the exception of one of Ettrick Forest, which is undated. From the Privy Council Records we know that Adair obtained a subsidy of £100 a year in 1682 to complete a series of county maps, but in 1686 he complains that he is "ready to perish" for want of funds. In 1692 he reported that four maps were complete, and proposed to go on with a series of "sea maps," whereupon taxes were ordered to be levied on shipping to provide funds for the preparation of maps for mariners. At this point Captain Slezer, described as a "High German," intervened with a claim to share the proceeds of the tax, on the grounds that he was preparing an important book on Scotland; and the claim was admitted, with the result that a dispute arose between the two authors which lasted many years. By 1694 ten sea-maps and ten land-maps were finished, but, though Adair continued to draw his subsidy and the work of engraving was put in hand, for some unexplained reason the issue of the maps was delayed. In the end five of the east-coast maps were issued in 1703 in a small atlas, with descriptions by Adair and a general map of Scotland. Besides these, seven others were eventually engraved, some not appearing till about the middle of the eighteenth century. In an inventory of the maps left in his widow's hands various others relating to the west coast are mentioned, but these were never published. Adair's maps were based, in part at least, on surveys carried out by himself.

Hydrology of the Po System.

The detailed study of the hydrology of the Po system inaugurated by the appointment of a Commission for the purpose in 1910 continues to make steady progress in spite of the war, and the results already gained are of considerable importance. A "Second Publication" of the Commission, reporting on the work done during the period December 1913 to June 1917 was issued at Parma in the latter year, accompanied by special reports on certain portions of the investigations, profusely illustrated by diagrams. As described in the general report of the director, Signor M. Giandotti, the operations include observations of rainfall at a number of stations within the Po basin (now reaching a total of 602, whereas only 164 were in operation in 1912), grouped according to eight zones, each embracing a definite section of the basin: of these seventeen are at an altitude of over 2000 metres; systematic records of river-level at stations on the Po and its tributaries; determinations of river discharge; forecasting of floods and of abnormally low stages; determination of matter carried in suspension; observations of water temperature; investigations of the level of ground water; besides special studies in the glaciated areas feeding the Po system. Of the special reports included in the present publication the most important is perhaps that dealing with the forecasting of floods—a matter obviously of the greatest practical importance. It not only places on record the detailed observations of river-level, barometric pressure, and rainfall during the six chief floods of the period in question, but enters into a comparison of the results with a view to deducing the laws of correlation between the floods and the rainfall and other factors influencing them—a necessary preliminary to a trustworthy forecast of the former. It appears that the type of pressure accompanying the floods was in the main of anti-Atlantic character during the colder parts of the year, but Atlantic in the warmer. The rainfall in the fourth zone, that of the Ticino basin, is seen to have had a preponderating influence on the floods as a whole, that in the basins of the Tanaro and Scrivia coming next. The tables and diagrams show a good general agreement between the total rise of level in the river in the various sections and the recorded precipitation, though certain anomalies are noticeable, due to disturbing factors such as the extent to which the precipitation is in the form of snow, the state of saturation of the soil, the intensity (as opposed to the absolute amount) of the rainfall, and the pre-existing stage of the river. With due regard to these it is hoped that correlation laws may be arrived at which may aid in forecasting floods from the telegraphic reports of precipitation. Other special reports deal with the observations of suspended matter and of ground-water level, and with the *règime* of the Lys, a glacial torrent descending from the Monte Rosa group. The last brings out graphically the correlation between the daily course of temperature and the water-level of the stream.

Weather and Harvests in Sweden.

A laborious statistical investigation by Axel Wallén is embodied in a monograph entitled "Sur la Corrélation entre les Récoltes et les Variations de la Température et de l'Eau tombée en Suéde" (*Kungl. Svenska Vetenskaps-akademiens Handlingar*, Band **57**, N. 8). The subject is introduced with some discussion of the method of obtaining the correlation coefficients, total and partial, between the yield of crops and the meteorological elements, which are set forth in the work; and whilst there is much in the latter to interest the pure mathematician, the geographer will be gratified to see the said correlative

information depicted in a series of coloured maps of Sweden showing the dependence of particular crops on the character of seasons. Thus in the case of wheat there is a large area in Central Sweden where in the months of August and September of the year of sowing a temperature *below* the average means the hope of a good harvest in the following year, the coefficient of negative correlation being high—varying between −0·5 and −1·0; but over much of the same area a *warm* February and March following is, to a lesser extent, also favourable to a good crop, the coefficient being smaller and then positive. Similarly, in a broad coastal strip in the south-east of Sweden a wet May may be expected to precede a heavy wheat crop, the coefficient ranging between +0·5 and +1·0. In the case of rye, again, the temperature of August shows high negative correlation with the crop of the following year over all northern Sweden, but in the south there is hardly any definite connection either way; and so on for the other crops in relation to the temperature and rainfall of the various months. It is pointed out that whatever value the results of this and like investigations may at present have, to the practical agriculturist it will be greatly enhanced when long-distance weather forecasting on lines already attempted by Hildebrandsson and Pettersson is attended with greater success than is now possible. If, for instance, a cold August could be predicted as very likely to occur in a certain year the knowledge of the high negative correlation between the temperature of this month and wheat-yield might, it is suggested, justify prompt steps in preparation for the autumn sowing of this crop. Wallén further points out that the coefficients which he has obtained and shown to have some significance would have doubtless been higher had they been based on the natural instead of on the political divisions of the country, on account of the greater uniformity of conditions in the former. The best results of all should be obtained for individual estates. This type of investigation is, of course, not new, and the results of Sir Napier Shaw in this country some years ago on the dependence of the yield of wheat in the eastern counties upon the rainfall of the previous autumn will be recalled (see *Journal*, vol. **26**, p. 83).

Russian Wheat.

The *Bulletin* of the Neuchâtel Geographical Society (vol. **26**, 1917) contains an elaborate paper by Léon Felde on the Production and Export of Russian Wheat. The first part (pp. 80) discusses very fully, if not very deeply, the whole question of production—soil, climate, technical and social conditions; the second part does the same for the commerce, dealing with internal and external transport from all points of view, but specially with exports to Switzerland. It is a very useful compilation, marred only by some rigidity, *e.g.* the fixing of germination at 6° C. and the accumulated temperatures being stated definitely as 2000°, the relation of higher accumulated temperatures to latitude and higher mean temperatures being thus ignored.

The spring-wheat area falls, typically, within the area of highest general culture. It lies parallel with the rain-bearing winds—north-eastwards from the Sea of Azov, along isotherm 22° C. (*c.* 71° F.) in July, while the winter-wheat area lies athwart the winds, parallel with the Black Sea coast, especially south-east of the Azov, *i.e.* along isotherm −4° C. in January. The spring-wheat area is, therefore, associated with greater range of temperature (having an average of −10° C. in January), as also with greater variation of yield, this having varied from 58,000,000 cwts. in 1906 to 148,000,000 in 1913; and such variation helps to account for the excessive variation in price, which even at Odessa varies from 29 per cent. below normal to 32 per cent. above, while at Saratov

it varies from 35 per cent. below to 62 per cent. above. Both areas have sudden increase of rainfall in May, then maximum in June–July, a dry autumn, and some increase of rain again in November or December. And it is, of course, the "temperate" winters that are bad for the winter wheat (p. 27)—in hard winters it seems to take no harm. In fact, wheat-growing is greatly facilitated by both soil and climate, but there are at present insuperable difficulties against introducing intensive culture, although the wheat area has—for Russia—quite a dense population (25 to 70 per square mile). In the absence of scientific agriculture, the result of this comparative density is that only sixteen governments, out of *c.* 70 in European Russia, have normally any surplus wheat for export; and this surplus is based on a *per capita* consumption of 150 lbs. in 1913, as against 60 lbs. in 1906.* Still, cereals make two-thirds of the total value of Russian exports, wheat having over one-third of the total cereal value. The transport is by both water and rail, the useful "floatage" being estimated at *c.* 90,000 miles and the navigable water at *c.* 28,000 (excluding Finland), with an annual duration varying from an average of 263 days (with a range of 50) on the Dnieper, to one of 231 days (with a range of 29) on the Don, and one of 223 (with a range of 67) on the Lower Volga. The statistical returns emphasize in the most marked way the insignificance of Odessa as a wheat-port. For some years it has never been in the list of the *first six*. It is generally far behind its two neighbours of the Dnieper liman, Kherson, and Nicolaiev—the latter, as an important railway junction on the only line to Kherson and with a much wider river, having the steadier trade of the two. All three together were not equal to Rostov in 1913, with its 17 per cent. of the total Russian export, while even Riga is usually at least as important as Odessa. The sheltered "Riviera" port of Novorossiskaya, the terminus of the Volga line from Tsaritsin, comes next to Rostov, with *c.* 9 per cent. of the total export, and has a very steady trade; and Taganrog usually stands third, though large quantities of wheat are exported from other Azov ports, *e.g.* Yeissk, Berdiansk, Mariupol, and Feodosia—which really counts as an Azov port. Altogether, *c.* 45 per cent. of Russian wheat exports go from the Azov, the Black Sea proper having only *c.* 40 per cent.; and the quantity in millions of pounds roughly approaches the value in millions of roubles (203 and 225 in 1913). For years before the war Russia had furnished Switzerland with her chief supplies of wheat, though by 1912 the proportion had fallen slightly below 50 per cent., while it was only 36 per cent. in 1913. The grain moved *viâ* Genoa or Marseilles or Mannheim, some going on as far as Strassburg or Kehl; and the manipulation of dues on the German railways was such that, though the water rate to Mannheim was *c.* 1400 francs per quintal as against 800 to Genoa or Marseilles, the total cost to Berne was only *c.* 3200 francs as against 3070 *viâ* Genoa and 3300 *viâ* Marseilles. The saving to Zurich was 300 francs greater. The extra time for delivery to Switzerland *viâ* the Rhine was 20 days.

There are some very clear and useful diagrams, dealing with temperatures, rainfall, distribution of spring and winter wheat, soil, etc., the last (p. 48) being on a large scale, and distinguishing very carefully the various classes of Black Earth, the texture and other conditions of which are described in detail on p. 52. From a later chapter it appears that in this region the earliest sowing of spring wheat varies with the locality from March 15 to April 10, and that of winter wheat from August 25 to September 15 (O.S., *i.e.* 13 days behind us), and the winter sowing requires 24 lbs. more seed to the acre. Reaping begins July 23—August 7 (N.S.) for spring wheat, and July 8–23 for winter

* The 150 per cent. increase is due mainly to the increase of urban population.

wheat, and it is in the reaping season that wages are highest. The average wage rose 15 per cent. in the ten years before the war, and female wages average *c.* 65 per cent. of male. L. W. LYDE.

AFRICA

The Fagibini Depression, north of the Upper Niger.

First discovered in 1894 (cf. *Journal*, vol. 7, p. 98), the depression occupied by the long narrow lake of Fagibini has attracted a good deal of attention on account of the somewhat puzzling morphology of the region (situated north-north-west of Timbuktu) in which it occurs, and the idea that has been put forward that the depression lies on a former more northerly course of the Niger. The latest contribution to the subject is a paper in the *Annales de Géographie* (15 January 1918) by the French traveller and geologist, Mons. R. Chudeau, who gives a systematic account of the district, based on his own and other travellers' researches, and accompanied by a sketch-map for which he has utilized the most recent astronomical determinations of position. A point on which M. Chudeau lays stress is the separation of Fagibini from the Niger throughout its whole length by a line of sandstone plateaux with generally horizontal strata. They occur again to the east of the lake (the northern border of which is formed by a long wooded dune), but are broken to the south-east by a nearly continuous depression occupied in part by Lakes Tele and Fati and linking Fagibini with the Niger, from which it receives its water-supply at the flood season. M. Chudeau holds that the depressions must owe their origin to tectonic causes. The extent of the principal lake varies greatly. The area covered in 1894 has never since been equalled, and the length during average floods is little more than half the maximum, whilst one or two subsidiary depressions in its neighbourhood are only exceptionally flooded. Its bed is generally level, but there are gulleys where a depth of about 100 feet is reached. Although the lake lies between 5 and 10 metres below the level of the Niger, the river-water takes a considerable time to reach it, as it has first to overtop two or three intervening sills and to fill the basins between them. The amount of water reaching Fagibini has become less and less of late years, and the result has been disastrous to cultivation, so that its borders have been nearly depopulated. Opinions have greatly differed as to the economic importance of the district, some holding that it might serve as the granary of the Sudan, others that any sums expended on its development would be wasted. M. Chudeau points out the small amount of work that would be necessary to open a regular channel from the Niger to the lake, and thinks that the water-supply so secured would permit the irrigation of a vast area, and that this would certainly be worth doing in a country which can grow three crops of wheat in a year. Cotton, too, is a crop which could be extensively cultivated. The paper also contains details on the natural types of vegetation of the region.

AMERICA

The Lower St. Lawrence and its People.

"In the Lower St. Lawrence Valley is established a civilization unique in its lack of progressiveness and picturesque in its proud adherence to the ancient customs of ancestral founders." This is the opening sentence of an interesting study of this region and the causes of its isolation contributed by Mr. R. Peattie to the *Geographical Review* for February 1918, as the result of a study of the literature followed by personal investigation during a 900-mile

trip on both sides of the estuary. Both shores of the estuary are bordered by rolling wooded uplands of monotonous aspect, and with a soil generally too poor for agriculture; that on the north ends abruptly in a bold escarpment 1500 to 2000 feet in height, while that on the south drops gradually to the lowland. For the most part the uplands are farmed only at the edge, population being grouped chiefly on the more fertile lower terraces, or in wedge-shaped valleys penetrating the highlands. The climate is of an extreme continental character, though with some modification towards the east by marine influence. Generally the winter is long and cold, the summer short and warm. Snow lies till May, but vegetation then rapidly springs to life, and, with a growing season of less than 150 days as a rule, grains will mature, as the summer day is long and the rainfall not too heavy. On the northern shore the one paying product is cheese (and even this a recent development), though the water-power everywhere present enables even the smallest settlements to support some industry dependent on the forest. With its greater extent of rich lowland, and with good railway communication, the southern shore possesses greater economic advantages. Primarily a farming district, it has some industries—generally some sort of wood-working—but none of the towns are large, and the isolation is merely mitigated. Although lying on one of the great commercial arteries of the world, the region, strangely enough, has poor water communication, due to the closing of navigation in winter and to the lack of good harbours, the approach to the shore being always shallow by reason of the recent uplift of the estuary. Under these physical conditions the primitive state of existence of the French Canadians has been maintained unchanged until quite recent years, and modern education has penetrated the region but slightly. Wood and farm products have furnished the foundation for a healthy commerce, but the primitive economy of the hinterland, the imperfect communication, and the lack of doorways of entrance to the territory have been formidable barriers. Within the past ten years some signs of change have become apparent, but the influence of visitors from the outside world is more than offset by the strictly French and Roman Catholic character of the population. Apart from language and religion, the visitor sees evidences of crystallization rather than development in the retention of old-world legends and ballads, in the survival of a modified feudalism, and in the way in which architecture clings to traditional lines.

Sketch-map of the Kootenay and Columbia Rivers.

We are asked by the author to state that the sketch-map on page 45 of the July *Journal* illustrating Mr. Baillie-Grohman's paper on "The Kootenay Country" was not supplied or revised by him, but was prepared by the Society's draughtsman from the official map of British Columbia, scale 1 : 1,125,000, Victoria, B.C., Department of Lands, 1912. He asks us also to say that the spelling Kootenai is still used in the United States.

AUSTRALASIA AND PACIFIC ISLANDS

The Australian Trans-Continental Railway.

We have received from Mr. Edmund O'Brien, a resident in Victoria, the copy of an article by him which appeared in the *Ballarat Courier* of March 2 of this year, describing a journey from Melbourne to Perth by the recently completed Trans-Continental Railway. The writer, who sends also a series of sections along the line of the railway, a table of mileage and altitudes, and a time-table of the train service, pays special attention to the physical features

of the country traversed, both as regards general configuration and the conditions of climate and vegetation on which possibilities of its utilization must depend. As is well known, the Highlands of Eastern Australia are separated from the great western plateau by the line of depression running north from Spencer Gulf. From Port Augusta, at the head of this gulf, the line—which between Melbourne and Adelaide and again between Adelaide and Port Augusta has made comparatively steep ascents for the crossing of the intervening highlands—mounts quite gradually to the level of the western plateau, not gaining an altitude of 1000 feet until some 950 miles from the starting-point, while the further ascent to Kalgoorlie (1240 feet) is effected within about 100 miles more. To the eye the plateau appears of a monotonous level, and at one part the line makes a straight run of 330 miles. In spite of its general aridity—for the whole region has a rainfall of less than 10 inches yearly—it is not a desert in the ordinary acceptation of the term, but even in the sandhill areas supports its own xerophytic vegetation, including mulga, salt bush, and blue bush. The plateau consists for the most part of very ancient crystalline rocks, but it includes in its south-central portion the Eucla limestone basin, sloping gradually down to the head of the Great Australian Bight. The vegetation here consists chiefly of salt bush and blue bush, with patches of grass-covered country. Water can generally be obtained by boring, but is unfortunately often brackish, and though suitable for stock needs distillation to render it potable by man. The writer quotes Mr. J. H. Maiden to the effect that what was once called desert in Australia has in many parts been gradually invaded by the wheat line, and suggests that, with "dry farming" and the choice of drought-resisting crops, it is quite possible that use may in time be made of the region for more than mere pastoral occupation, for which the greater part is in any case well suited. Before the 1000th mile from Port Augusta is reached the line enters the region of granite and other ancient crystalline rocks in which the gold deposits of Western Australia occur; and at about the same point the salmon gum with its salmon-tinted trunk becomes more plentiful, extending throughout the goldfields region. The whole journey from Melbourne to Perth, a distance of 2168 miles, occupies nearly four days, passengers leaving the former at 4.30 p.m. on Mondays and Wednesdays and arriving at Perth at 9.23 a.m. on Fridays and Sundays; but this includes a stop of 8 hours 40 minutes at Kalgoorlie (in the goldfields), where apparently it is necessary to change trains. During the journey watches are put back three times—30 minutes at Serviceton (287 miles from Melbourne) on changing from Victorian to South Australian time; 45 minutes at Tarcoola (999 miles) on reaching the zone of Central time; and 45 minutes again at Rawlinna (1558 miles), on entering the domain of West Australian time. [NOTE: "Central time," apparently $8^h\ 45^m$ fast on G.M.T., is not included in the official list of standard times published in this country. The introduction of changes of 45 minutes adds to the existing abnormality of Australian standard times, and is regrettable.—ED. *G.J.*]

MATHEMATICAL AND PHYSICAL GEOGRAPHY

Solar Radiation Variations and their Effects.

Evidence was obtained some years ago that there are variations in the output of solar radiation with intervals of only a few days between the maximum and minimum intensity, and a recent investigation of some importance is that of Mr. H. Helm Clayton, who traces the effect of such short-period variations on the Earth's atmosphere (*Smithsonian Miscell. Coll.*, vol. 68, No. 3; 1907). He

bases the investigation on measurements made by Dr. Abbot with the bolometer at Mount Wilson, California, during 1913 and 1914, for the purpose of measuring the variability of the solar radiation, the results being expressed in calories per minute corrected so as to represent values outside the atmosphere. The comparison between the solar and terrestrial atmospheric changes is effected by the statistical method of correlation. The preliminary step was to study the effect of changes in the amount of solar energy received by the earth upon the temperature conditions observed at some continental tropical or subtropical station such as would be likely to respond most readily to solar variations. The station selected was Pilar, in central Argentina, lat. 31° 39′ S., long. 63° 51′ W., where there was a fairly good temperature record; the correlation coefficient found between the afternoon maxima of temperature at that station and the solar radiation values at Mount Wilson was so high as to justify the investigation being extended to the temperature records of other parts of the world. The computations indicate a maximum positive correlation in the tropics on the second day following the solar observations, a maximum negative correlation in the temperate zone and subtropical occurs on the third to fourth day following, and a maximum positive correlation in the Arctic zone on the second day. Clayton observes that the later occurrence of the negative correlation indicates that it is a secondary effect of the solar action in other parts of the world; and, indeed, it might be noted that the whole distribution is quite in keeping with that which on *à priori* considerations has more than once been predicted—namely, that while tropical land areas would almost certainly respond in temperature to any increase in the intensity of solar radiation, the actual effect in temperate latitudes might be reversed on account of the increased flow of polar winds which would ensue. In order to ascertain to what extent atmospheric pressure responded to the temperature changes, the solar radiation was next correlated with the pressure, and the result is in general to show that in those regions where the temperature correlation was positive the pressure correlation was negative, and *vice versâ*. Other aspects of the investigation are dealt with by the author, who illustrates the course of events by an instructive series of coloured charts. He finally summarizes his conclusions as follows: (1) That there is an intimate relation between solar changes and meteorological changes of short period, and that measurements of solar radiation like those made by Dr. Abbot and his associates have the greatest importance in meteorology; (2) that there is a class of meteorological changes which have their origin in equatorial regions, and by a transference of air, probably in the upper layers, are felt within a few days in higher latitudes.

Tide Prediction in the North Sea.

In the course of a discussion on tides, arranged by the British Association Committee for the discussion of geophysical subjects, and held at the rooms of the Royal Astronomical Society on Wednesday, 12 June 1918, Commander Warburg, R.N., made an announcement of much interest. When he was appointed some years ago in charge of the tidal predictions in the department of the Hydrographer of the Navy, he entered upon his duties with a keen desire to extend the harmonic analysis of prediction of tides on the British coasts. As a result, however, of several years' comparison of observation and of prediction, he is able to say confidently that the tides of the North Sea are not well represented by harmonic terms of the periods suggested by dynamical theory and sought in the analysis. This confirms a conclusion announced by the German Hydrographic Office several years ago. The tide tables for the

North Sea are now computed by an empirical process which is for the present undescribed. It gives results which represent very satisfactorily the tides on both coasts, and it is interesting to learn that the British tide tables for the Heligoland Bight agree very closely with those obtained from a captured German submarine, which are also evidently based upon some process other than harmonic analysis. These facts are of great theoretical as well as of practical interest. They indicate the necessity for an investigation whether the divergences from theory in the confined and shallow waters of the North Sea are to be accounted for by free oscillations resembling *seiches*, or by interference of the tidal wave coming up channel and round the north of Scotland.

CORRESPONDENCE

The Grave of Dr. Oudney.

IT may be of interest to the Society to learn that the burial-place of Dr. Oudney, who accompanied Denham and Clapperton to the Sudan in 1822–4, has, I believe, been identified at the village of Chacharam, in the Katagum Emirate. It was pointed out to the District Officer by an old inhabitant of the village, who had heard the details of the death and burial from his father and other elders of the previous generation. In his youth, he says, traces of the wall or fence which had been erected round the grave were still visible, though they have now disappeared. A new wall is being built round the spot to mark it.

I have not heard of any previous identification of this grave, and its discovery now may, as I have said, be of some interest—the more so perhaps as Clapperton's place of burial has never, I think, been identified with certainty, though repeated attempts to do so were made by Major Burdon when he was Resident at Sokoto.

Yours faithfully,
W. J. GOWERS.

The Residency, Kano, Nigeria,
16 May 1918.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1917–1918

Thirteenth Evening Meeting, 10 June 1918.—The President in the Chair.

ELECTIONS.—Lieut. G. O. Blacker; Miss M. Y. Lyle; W. L. Milner; Miss Lucy Ormrod; C. A. Stewart; Miss Kathleen Webb; Lieut. W. F. Willis, R.F.C.

PAPER: The Backbone of Africa. Sir Alfred Sharpe.

Fourteenth Evening Meeting, 24 June 1918.—The President in the Chair.

ELECTIONS: Major H. V. Bacon; Mrs. Bacon; Sir Montagu P. Beauchamp, Bt.; Lieut. C. A. Blackburn, M.C., R.G.A.; Rev. Peter Brookfield, O.S.B.; Major Kinahon Cornwallis, D.S.O.; J. C. Fraser; Rev. S. D. Gray; Lieut. C. R. W. Griffiths; E. L. Hall; C. E. Hooks; Lieut. T. H. Hughes, R.E.; Sydney Humphries; Major F. C. Jack, R.F.A.; Lieut.-Col. A. W. H. M. Moens, D.S.O.; Capt. W. Parks, R.E.; E. E. Potter; Capt. A. E. Woodhead, R.E.

PAPER: Canadian Natural Resources and their State Control. Hon. Arthur Meighen, Minister of the Interior.